POWER

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Spares

DID you ever think what it cost to shut down a shop or factory for even a few minutes? In the loss of time of employees, in spoiled material, in lessened production and sacrificed profits, the figures are in many cases stupendous.

If you are an engineer, you know that a shutdown on account of boiler or engine-room trouble will put a blot on your reputation and bring down on your head the outpouring of vials of wrath from the management.

Some engineers are "lucky" in this respect; others are always in trouble.

The lucky ones are those who see trouble ahead and ward it off.

While the less effective man is floundering in difficulties, nursing his grievances or dreaming of what he will do and be when the big job comes his way, the "lucky" man is dreaming and planning and going over in his mind what he would do if such and such a thing should happen. The result is, that it usually does not happen, for he has thought out the incipient indications of it and is on the lookout for them, but if it does come, he has lived it through, in thought at least, before and has a plan of action all prepared.

He must not only know what to do first and quickly, but have the material at hand to do it with.

Many a shutdown could be not only minimized but prevented altogether by the possession of the necessary spare parts. The watchful engineer, master mechanic, electrician or superintendent who sees something about the plant beginning to give out or feels that it is about time for a piece of apparatus to begin to give trouble, can, if he has the necessary spares, forestall a possible shutdown by immediate renewal; whereas, if the repair or renewal parts are not at hand, he may take a chance upon the apparatus holding out a little longer. Even if he orders them then, disaster may come before they arrive.

It costs little to have extra parts of stokers, valve gears, pump valves, pistons, etc., that are subject to frequent renewal, particularly susceptible to accident or of extreme importance to the continuous operation of the plant, right at hand and in condition for immediate use. The prevention of a single interruption of service, the shortening of the period of a single shutdown, may save the cost of all the spares that one would carry. Some of them may never be needed, but when they are needed, they are, like the Texan's pistol, needed mighty bad.

F. R. Low

Burning Anthracite Mine Waste Efficiently

Results of Tests Obtained by Burning Pulverized Anthracite Coal in the Philadelphia Rapid Transit Co's. Power Plant—Pulverizing Equipment Installed for Ten Boilers—One Boiler Put in Operation to Date

By O. M. RAU*

ACCUMULATION of culm from anthracite mines has been going on for years until mountains of this material have formed in these mining regions. The creeks and streams draining this area of the country contain deposits which, if recovered, would add materially to the anthracite fuel supply. Estimates of the total tonnage of these accumulations varies from

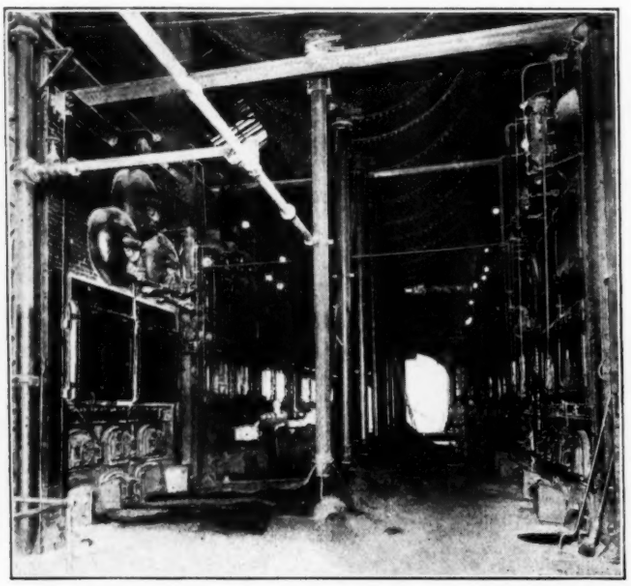

FIG. 1. BOILER ROOM BEFORE PULVERIZED COAL BURNING EQUIPMENT WAS INSTALLED

fifty to one hundred million tons and the recoverable coal in the streams alone is estimated at millions of tons.

This material in the past was considered waste incident to anthracite mining and averaged approximately 10 per cent of the coal mined, and up to the time of the fuel shortage during the war, little if any effort was made for its use. At this time the high B.t.u. value of this material attracted the attention of engineers to its possible use as a fuel for steam boilers, resulting in extensive reclaiming operation being started by the mining and other interests to work over these accumulations. The high price of steaming sizes of anthracite left sufficient leeway to sell this reclaimed coal at a price that made these operations profitable, although only a small portion of the fuel was recovered, since only the larger particles found a market, owing to the difficulty in burning the finer material economically.

The use of the fine coal as fuel has not been attended with any great degree of success, although a number of plants have furnaces equipped with suitable grates and stokers. While its use was attractive during the peak prices for coal, this interest is being largely abandoned with the present conditions of the coal market. Particularly is this true in the use of so-called river and creek coal, the reclaiming of which resulted in establishing a substantial industry along the different creeks and streams in the anthracite district, which was reclaiming approximately 10,000 tons a day up to the time the prices of steaming-size coal were lowered.

As power expert for the United States Shipping Board the author made an extensive survey of the power situation in the Philadelphia district, and as a result of this survey an investigation was undertaken to ascertain the possibilities of utilizing this mine waste in pulverized form. The large percentage of noncombustible and the difficulty of pulverizing to a fineness that would assure efficient combustion were outstanding obstacles. Studies were made of various methods of screening, jigging and other devices for the reduction of the ash. The method known as Trent

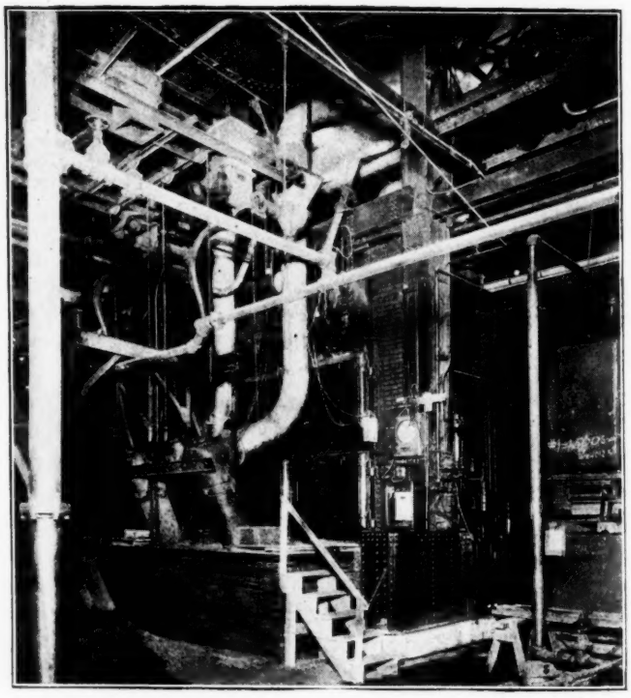

FIG. 2. BOILER EQUIPPED FOR BURNING PULVERIZED ANTHRACITE COAL

process, which at that time was being developed at the United States Bureau of Mines, makes possible a reduction of the ash to a predetermined amount.

The pulverizing of anthracite culm, silt or river coal was found to be attended with difficulty and considerably more expense than the cost of pulverizing bituminous or other soft coal. The various attempts to pulverize

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anthracite were analyzed and the action on mills of the Fuller, Raymond, tube and pebble types was noted, with the result that it was found to be commercially feasible on a basis of a mill capacity of one-half that obtained with bituminous coal and with about double the maintenance expense.

Experiments were then made to burn pulverized anthracite in existing installations. A 1,000-ton shipment of culm was sent to the Lima Locomotive Works to make a practical demonstration. This plant was selected as it had seven boilers in operation on pulverized bituminous coal. The only change made in the operation of the plant was to deliver the anthracite to the pulverizers in place of bituminous as formerly. The test developed no difficulties in burning this fuel, but indicated the desirability of modifications in the design of the installation if the best results were to be obtained.

With these preliminary studies completed and the possibilities of a material saving in power costs assured, the Philadelphia Rapid Transit Co. approved a trial installation in its Thirteenth and Mt. Vernon Street power plant. This plant was selected as the boilers were handfired, and being located in a semi-residential neighborhood it was restricted to the use of anthracite fuel. The plant operated part time as a peak-load power source and carried upward of 10,000 kw. for short periods during the evening loads, operating at a reduced output during the rest of the day with little or no load nights and Sundays. In addition to the change from hand-firing and the use of low-grade fuel it also would eliminate the use of coal for banking.

The plant consisted of 20 B. & W. boilers, each having 3,917 sq.ft. of water-heating surface, 5 Weatherall compound Corliss engines direct-connected to 1,500-kw. direct-current 500-volt generators exhausting into two 800-kw. direct-current vertical Curtis exhaust-steam turbines, giving the plant approximately a total capacity of 10,000 kilowatts.

A portion of the street-railway system's downtown section is operated from this plant, and until the high coal prices it was able to deliver power to the trolley at a cost that compared favorably with that delivered from the substations in this vicinity. The fuel used was No. 1 buckwheat at $3.50 per ton; when this coal in-

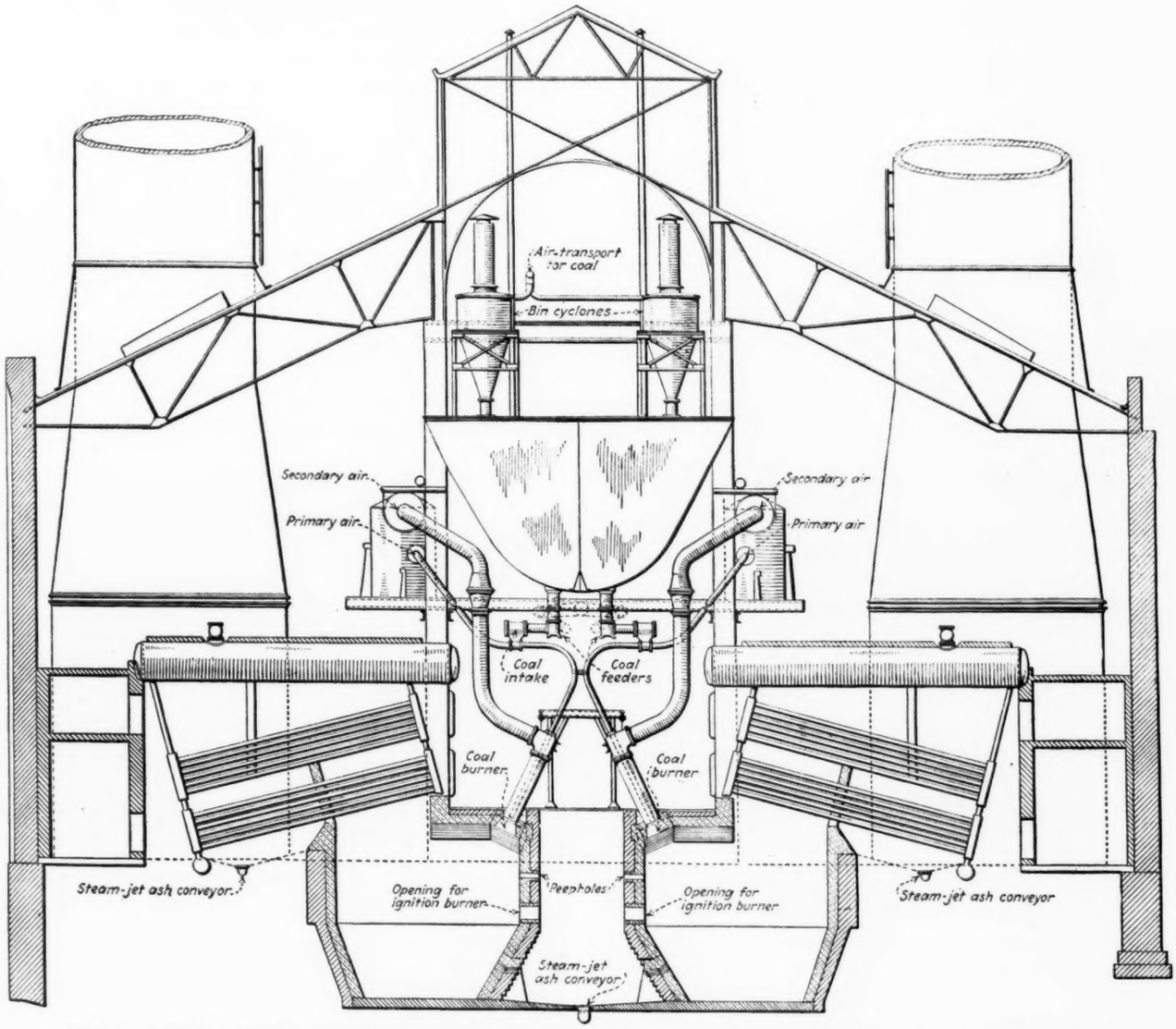


FIG. 3. CROSS-SECTION OF BOILER PLANT SHOWING GENERAL ARRANGEMENT OF PULVERIZED-COAL EQUIPMENT

creased to $5 and finally reached a price of $8 per ton, the plant was restricted to peak-load service. This resulted in a considerable expense for coal to maintain fires between peak periods and the cost per kilowatt-hour became excessive.

The boilers are set in two rows of ten each (see Figs. 1 and 3) with a stack midway in each row. Only ten boilers on the north side of the stacks were selected to be equipped for burning pulverized fuel, since the

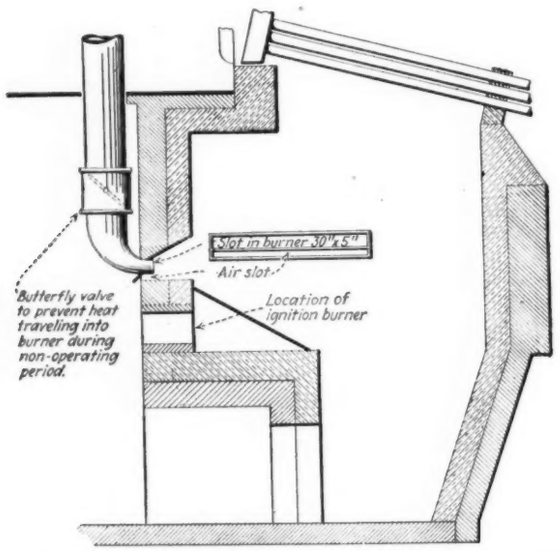

Slot in burner 30"x5"
Air slot
Butterfly valve to prevent heat traveling into burner during non-operating period.
Location of ignition burner

FIG. 4. SECTION THROUGH REMODELED FURNACE

increased rating at which the boilers can be operated with this fuel over hand-firing would give ample steam to operate the plant at full capacity.

In the boiler room the principal changes consisted of placing dust-tight partitions in the existing Berquist-type coal bunker, so that each boiler would have its own pulverized-coal storage bin with a capacity of approximately 25 tons. Beneath the coal bunker and supported therefrom 20 Quigley screw-type pulverized-coal feeders (two for each boiler) were installed. These were driven from a shaft extending the full length of the bunker and operated by a 15-hp. motor arranged for duplicate installation in case of motor trouble. Each feeder is equipped with a clutch engaging with a chain drive from the main shaft.

Primary and secondary air is provided by two sets of direct-connected Clarage fans supported on a platform at a level with the top of the boilers, so as to eliminate all unnecessary bends in the air lines. Each set of fans supplies the necessary air for five boilers. The primary fans have 25-hp. motors and the secondary fans 15-hp. motors. The secondary air supply is controlled by grid-type air gates, which insure a distribution of the air through the entire area of the pipe, independent of the quantity delivered. The primary air is controlled with a diaphragm which, after proper adjustment, is permanently set.

The furnace changes consisted of combining the former combustion chamber and ashpit and extending this space in front of the boiler so as to form one large combustion chamber; into this chamber the Quigley burners enter at an angle through the top of the extended portion in front of the boilers. The total volume of the combustion chamber as constructed is 1,542 cubic feet.

Two 14-in. burners are required for each boiler The fuel is fed into the burners through a 3½-in. pipe entering in the center of the secondary-air elbow and extending approximately two feet into the burners (see Fig. 3. The primary air and fuel enter the burner through this pipe and mix with the secondary air entering through the large opening. This allows for a thorough combination of the mixture into a combustible dust before being discharged into the furnace.

To insure rapid ignition of the anthracite when putting a boiler into service, which, owing to the low percentage of volatile in this kind of coal, does not ignite as readily as bituminous, the furnaces were equipped with two oil burners. These burners are capable of operating the boilers with oil fuel at their rated capacity. Burners of this size were selected so that in case of difficulty in obtaining raw coal, or accident to the pulverized-fuel system, oil could be temporarily used. This arrangement insures continuous operation and avoids expensive duplication of plant equipment. Owing to the similarity of the combustion chambers for burning oil with those for pulverized coal, the latter allow the use of oil with very efficient results, an advantage not possible with furnaces equipped with other methods for burning coal. The amount of oil required to ignite the pulverized coal varies from 30 to 40 gal. with a cold boiler and 10 to 20 gal. between peak-load operating periods.

The milling plant, Fig. 5, which is adjacent to the boiler plant is in a separate steel structure covered with

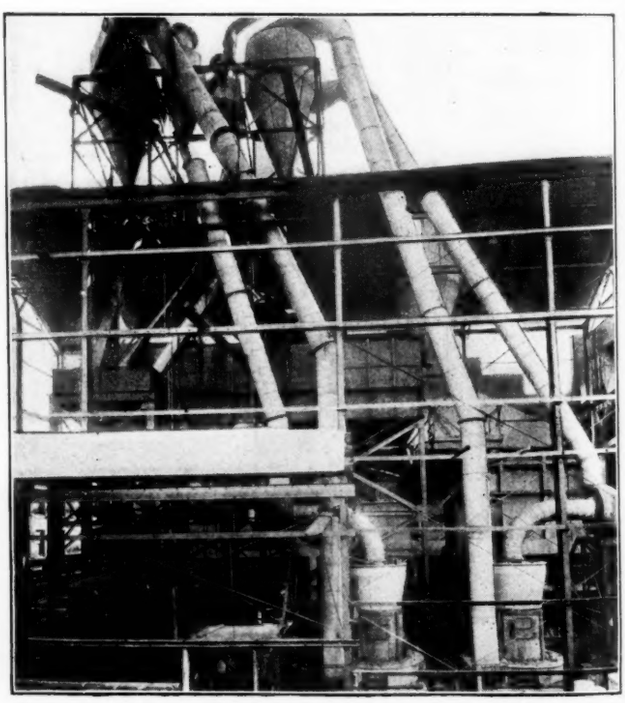


FIG. 5. VIEW OF PULVERIZED-COAL MILLING PLANT

corrugated iron and equipped with two highside Raymond mills, one Ruggles-Coles drier and a Quigley air-transport system.

Raw coal is elevated to a 100-ton bin and is fed with a screw feeder to the drier, from which it is elevated to the dry-coal bins above each mill, into which the feed is by gravity. The pulverized fuel is discharged through cyclone collectors above the roof of the building

into a pulverized-fuel bin over the transport tank. This tank rests on a platform dial scale and can be charged with such amounts of fuel as desired, up to 10,000 lb. Air pressure is then applied and any portion of fuel in the tank can be transported to any one of the coal bunkers in front of each boiler By means of a signal system the boiler-room attendant can notify the milling plant when coal for any bin is required, and by adjusting the switch valve for the particular bin the amount of fuel required is automatically delivered.

This equipment installation was completed by the Quigley Furnace Specialties Co. in the latter part of 1920. As soon as the combustion chamber under one boiler was ready, this boiler was put into service and operated for a short period, during which time some modifications were made in the combustion chamber and the burners were equipped with mixing vanes. On Nov. 23, 1920, the formal test was made, indicating full performance of the guarantees with the exception of the amount of combustible in the ash. However, as the effect on the efficiency was negligible, the plant was accepted.

These test data were limited to the conditions of the guarantee, which did not take into consideration the

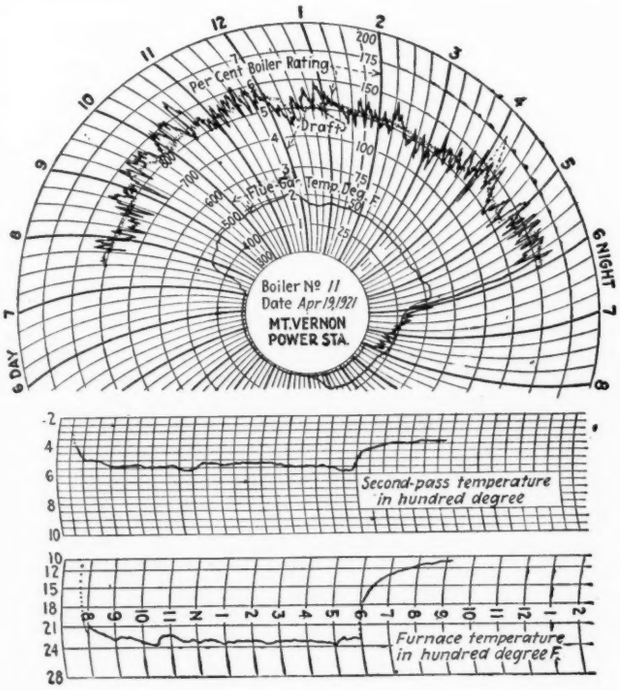


FIG. 6. BOILER-OPERATION CHARTS

boiler efficiency, but were based on the specific performance of the furnace and were specified as follows:

A. Capacity of pulverized fuel plant.
B. Fineness of pulverized coal.
C. Capacity of feeders.
D. Percentage of unconsumed combustible in ash.
E. Percentage of CO_2 in products of combustion.
F. Abrasion or effect on refractories in combustion chamber.

Further experimental operations were continued by the Philadelphia Rapid Transit Co.'s engineers to determine the most effective procedure for the equipment of the additional nine boilers. Careful observations were made of all parts of the installation to note developments of any defects or changes that might suggest themselves. Particular attention was paid to the condition of the combustion chamber, and after approximately six months' intermittent operation of the equipment, it was decided for comparative observation to reconstruct the combustion chamber, change the burners and install a new feeder.

The feeders furnished with the installation are of the screw type, having a capacity of 2,200 lb. per hour each,

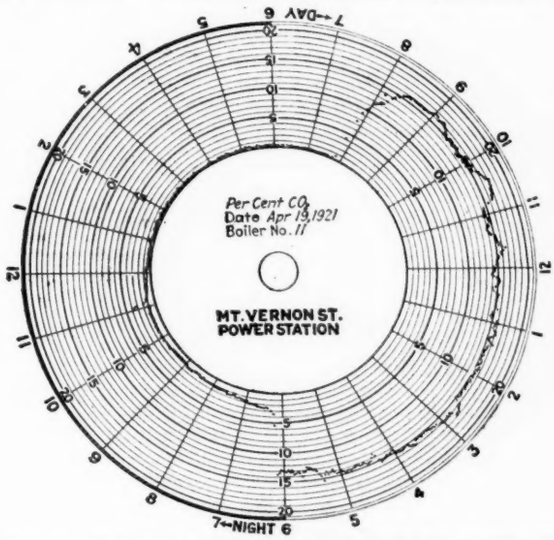


FIG. 7. PER CENT CO_2 CHART FOR BOILER FIRED WITH PULVERIZED ANTHRACITE COAL

and when the coal supply is permitted to become low in the bins and then filled up, there is a tendency for the feeder to flush, which is inherent to all screw feeders of this type, and which can be practically eliminated in regular operation by keeping the proper amount of coal in the bins. To avoid the necessity of close attention to the coal bins, it was decided to install a feeder suggested by the writer and designed and built by the Bailey Meter Co., of the bucket type with an attachment to record accurately the fuel feed to the furnace.

The burners were replaced by two multi-mix burners, and the combustion chamber was redesigned and considerably reduced in size. It was assumed that by providing these special means of mixing the air and fuel to a theoretically perfect combustible mixture, it would relieve the combustion chamber of functioning as a mixing chamber. Therefore the combustion chamber could be materially reduced in size, which is a desirable advantage in the application of pulverized coal to old installations.

In rebuilding the combustion chamber, a change was made in the location of the burners so as to allow for the construction of an ignition chamber to be built around the burner nozzles as they enter the furnace. Instead of the burners entering the top of the furnace as in the original designs, they were installed as near the bottom as practical (see Fig. 4).

With these changes further tests were conducted, the conclusion of which indicated that as good or better results were obtained with the original equipment with the exception of the combustible in the ash. By adding an ignition chamber to the original design, placing the burners in the lower portion of the furnace and maintaining the volume of the combustion chamber as first installed it is believed that the complete burning of the combustible in the fuel can be accomplished, with efficiencies equal to mechanical stokers on high-grade fuels.

Abstracts of the principal items of the tests covering the results of the original and of the revised installations are herewith comparatively tabulated:

	Original Installation	Revised Installation
Kind of boiler	B. & W.	B. & W.
Volume of combustion chamber, cu.ft.	1,542	800
Number of burners	2	2
Distance of flame path to heating surface, ft.	24	14
Water-heating surface	3,917	3,917
Ratio of combustion-chamber volume to water-heating surface	1 to 2.54	1 to 4.87
Date of test	11/23/20	8/23/21
Duration of test, hours	12	10
Steam pressure, gage	148	149.2
Temperature of feed water entering boiler, deg. F.	45.4	77
Temperature of escaping gases leaving boiler, deg. F.	447	487
Temperature side walls of combustion chamber, deg. F.	2,400	2,500
Moisture in coal as fired, per cent	0.87	0.46
Total weight of dry coal	25,987	25,950
Percentage of ash in pulverized coal	18.2	18.5
Total combustible fired	21,304	21,150
Total water evaporated	182,217	168,270
Factor of evaporation	1.218	1.185
Total equivalent evaporation	221,941	199,400
Dry coal fired per hour	2,165.6	2,595
Dry coal burned per hour, per cu.ft. of furnace volume, lb	1.4	3.25
Equivalent evaporation per hour from and at 212 deg. F., lb	18,495	19,940
Per cent of rated capacity developed	143	154
Calorific value of 1 lb. of dry coal	12,029	11,990
Calorific value of 1 lb. combustible	14,630	14,720
Per cent efficiency of boiler and furnace	69	62.2

It will be noted that the efficiency of the test with original equipment was higher than after the changes were made, although the combustible in the ash was less in the revised installation. The burned-out ash is accounted for by the effect of the ignition chamber, and the lower efficiency by the failure of completing combustion of the fuel in the smaller chamber.

The results of these experiences remove all doubts as to the successful burning of anthracite mine waste or river coal in pulverized form. When the remainder of the installation at the Thirteenth and Mt. Vernon Street Plant is completed, with the improvements and changes suggested by the preliminary operation, it is expected that efficiencies in excess of 76 per cent at ratings as high as 250 per cent will be obtainable. The tests and operation of this boiler have fully demonstrated the exceptional control possible by pulverized-coal firing, comparing very favorably with oil or gas

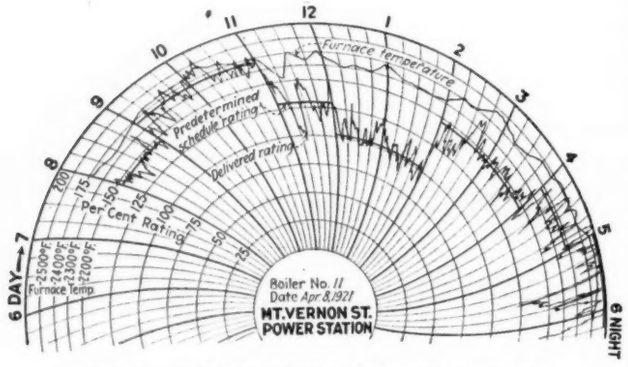


FIG. 8. BOILER-RATING SCHEDULE CHART

firing. As shown by the boiler-meter chart, Fig. 8, which recorded the performance of the boiler during a ten-hour period on a predetermined schedule of rating, the results were as follows:

Time	Schedule Rating, per Cent	Delivered Rating Average, per Cent	Furnace Temperature, Average, Deg. F
8 to 9	150	145	2,375
9 to 11	175	170	2,372
11 to 12	125	130	2,350
12 to 2	100	111	2,320
2 to 4	150	145	2,425
4 to 5	175	170	2,500
5 to 6	200	190	2,510

A Home-Made Electric Heater

By G. F. White

A few electric heaters will be found to be of great convenience around a power house or manufacturing plant to provide warmth in temporary locations, such as repair jobs, where there is no other heat available, drying motors or generators, and as resistance units for starting motors or furnishing testing current.

Heaters are quite simple from the theoretical point of view, as they essentially consist of coils of resistance wire. In practice, however, the ordinary conducting

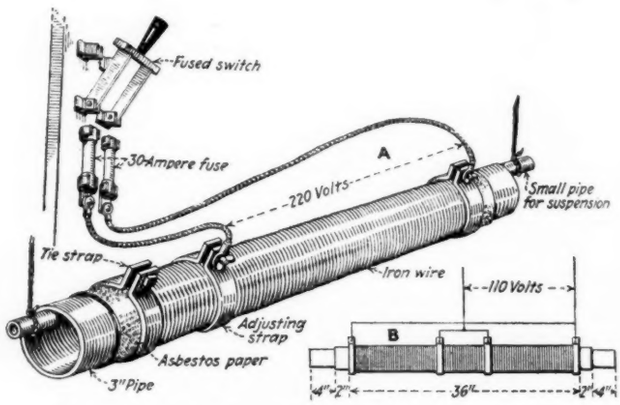


DIAGRAM SHOWING CONSTRUCTION OF HEATER

materials are not readily adaptable for small heating units. The heater shown in the diagram can be made of materials that are available in most plants, and it can be made up in a short time.

A piece of iron pipe of approximately the dimensions indicated can be found on almost any scrap heap and cut, if necessary, to the proper length. Flexible sheet asbestos or asbestos paper is the best material for insulating the pipe and withstanding the heat. Iron bale wire, telegraph wire or similar size of binding wire may be used. If the sheet asbestos is not available, old asbestos brake-band lining or sheet mica may be used. The contact straps can be made of hoop iron and clamped with stove bolts or small machine bolts. The adjusting strap can be moved along the heater so as to obtain the desired temperature.

This size, shown at *A*, is for 220 volts. If 110-volt service is desired, a heater can be made one-half the length or half of the diameter. With the sizes given in the figure, 110 volts may be used by means of a multiple connection as shown at *B*.

The pipe can be supported on bricks at each end or suspended by means of a small pipe extending through it or by attaching wires to the pipe itself. It should be remembered that this heater constitutes an electromagnet and as such will have a tendency to swing toward an iron body and toward or away from a similar heater. This action is especially noticeable on closing the switch, consequently care must be exercised not to allow the heater to swing around and cause short-circuits or grounds.

The heater may be used on alternating or direct current. The former is not so desirable on account of the low power factor of this device and of the additional heating effect of the alternating-current flux in the iron-pipe core. This heater will stand rough usage and yet be ready for work at nearly all times.

Boiler Explosion at Mechanicsville, N. Y.

On August 22 at about 1:10 p.m. one of the four horizontal return-tubular boilers in the rotary room of a paper mill at Mechanicsville, N. Y., exploded with violence. Five men who were in the room at the time of the explosion lost their lives, and the property damage was in excess of $40,000. The boilers were operated at a pressure of about 125 lb., the safety valves being set to relieve at 130 lb. pressure. The boilers were not directly fired, but utilized the waste heat voided from

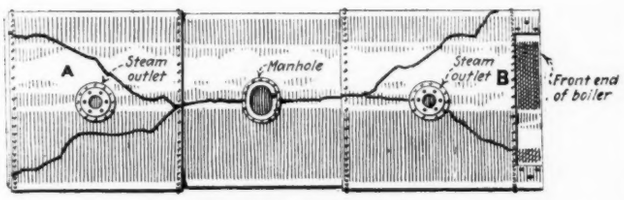


FIG. 1. LINES OF FRACTURE IN SHELL OF THE EXPLODED BOILER

four rotary furnaces, the furnaces being operated in reclaiming soda ash from liquor after its use in digesting wood for the manufacture of wood pulp.

The lines of fracture in the shell of the exploded boiler are roughly indicated in Fig. 1, which is a plan view of the boiler shell. The end portion, marked *A*, could not be found after the accident, it probably having been blown into a canal in the rear of the rotary room.

The four boilers were set separately, each being placed in a heavy brick-lined steel casing, in a manner commonly referred to as a "steamboat setting." All portions of the shell of the exploded boiler as well as the steel casing, with the exception of the section

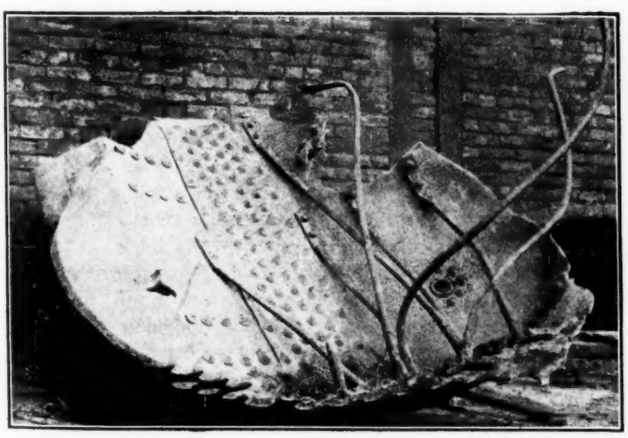


FIG. 2. PORTION OF BOILER SHELL DESIGNATED AS *B* IN FIG. 1

marked *A*, Fig. 1, previously referred to, and a similar section marked *B*, were found at the spot where the boiler had stood. The portion marked *B*, which is illustrated in Fig. 2, was blown a distance of about fifty feet from the location of the boiler. The tubes, with the exception of a few which remained at the point where the boiler had stood, were scattered over a wide area.

The longitudinal seams of the shell were butted and double-strapped with three rows of rivets on each side of the seam, or what is commonly known as a triple-riveted butt-strap seam. None of the longitudinal seams failed, but the larger portion of the rivets in the girth seams were sheared off. Tests on pieces of torn plate show quality equal to present standards. There was no evidence of an overheated plate.

The two boilers immediately adjacent to the one that exploded were thrown down and the pipe connections

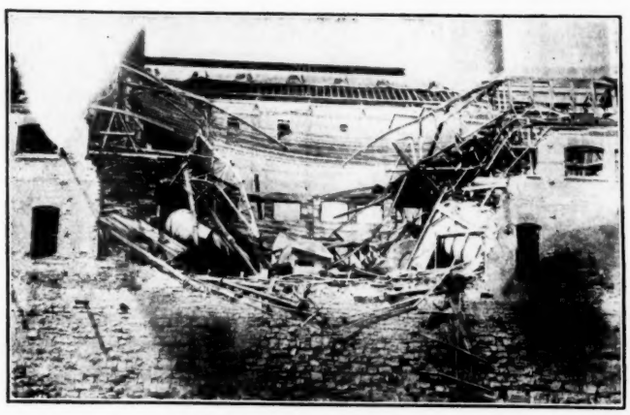


FIG. 3. SHOWING DESTRUCTION WROUGHT BY THE EXPLODED BOILER

knocked off. The boiler to the left had two small holes pierced in its shell at about the "two o'clock" position on the side next to the exploded boiler, these holes evidently having been caused by contact with the reinforcing rings of the manhole opening and pipe connections of the exploded boiler. The left-hand side of the boiler to the right of the one that exploded was also dented in where the framework of the casing had been forced against it. The ruptures in the shell of the exploded boiler were all through perfectly sound material, and there were absolutely no defects of any character in the structure to account for the accident. The violence of the explosion, together with the nature and location of the fractures in the shell, appear to indicate that the accident was the result of an over-pressure.[1]

That the explosion was of extreme violence was evidenced by the destruction wrought, which is illustrated in Fig. 3, as well as the fact that several store windows about a mile distant were broken by the concussion. It is difficult, if not impossible, to explain how such a high pressure as would be required to rupture the boiler in the manner noted could have been reached in this particular boiler. The fires supplying the rotary soda burners in front of the boiler that exploded, as well as the two mating boilers each side of it, were started about 7:30 a.m. on the morning of the accident and none of the boilers had been cut in on the line at the time of the explosion. The stop valves connecting the boilers to the header were all found closed after the accident. The time that had elapsed between the firing of the boilers and the explosion was about the usual time required to raise steam to the line pressure of 125 lb., and it would be anticipated that the boilers should have been about ready to cut into the line at the time of the accident.

That no manipulation of the main stop valves had occurred, however, is shown by the fact that they were

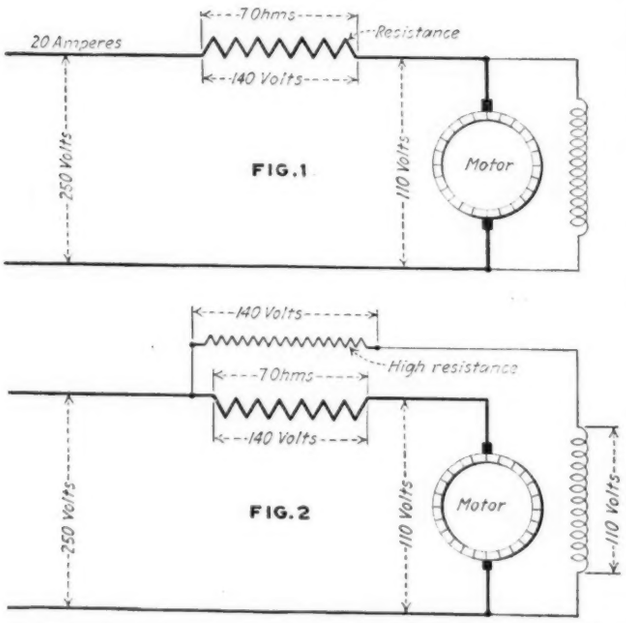
[1] A second theory is that an inherent defect in the safety-valve nozzle finally let go at normal pressure, permitting water to rise and causing a water-hammer explosion.

all found tightly closed, with the valves so broken that they could not have been manipulated after the explosion, and the further fact that the only man who would have performed the operation of cutting the boilers in was killed while standing on the floor at the side of the exploded boiler or sitting very close to it. The safety valve which served the exploded boiler and which was of the spring-loaded type, was hurled a distance of about 600 ft. and came down through a concrete roof. While this valve was not broken in its flight, the end of the spindle had been slightly bent and it must have been severely shocked. When tested after the accident, this safety valve began to leak at a very low pressure; it commenced to open at about 100 lb. and at between 110 and 120 lb. it was blowing freely.

Operating a Direct-Current Motor on Increased Voltage

BY H. D. MATTHEWS

To take care of an emergency, it is sometimes necessary to operate a motor on a higher voltage circuit than the machine is rated for. Under such circumstances in order to reduce the voltage to the proper amount for the



FIGS. 1 AND 2. DIAGRAM SHOWING RESISTANCE CONNECTED IN SERIES WITH A MOTOR

motor, a resistance box is placed in series with the machine. Suppose, for example, a motor rated 110 volts and 20 amperes, is to be operated on a 250-volt circuit. With the normal load on the motor and the voltage adjusted to 110 volts at the motor terminals, the voltage drop across the resistance box would have to be 250 — 110 = 140 volts. The resistance necessary for this condition would be volts ÷ amperes = 140 ÷ 20 = 7 ohms. With normal load the line voltage would be divided into 140 volts across the resistance box and 110 volts across the motor terminals, as indicated in Fig. 1. Inasmuch as the voltage drop across the resistance box varies directly with the current, it will be seen that any variation of current will change the applied voltage to the motor. This has the main objection of changing the field strength of the motor as well as causing a change in speed due to the change of voltage on the motor. For example, take the extreme condition that would be obtained at starting. Let it be assumed that the resistance of the armature for this particular motor is 0.5 ohm. The total resistance in the circuit is 7 + 0.5 = 7.5 ohms, and the starting current that would flow when the circuit was closed is total volts ÷ total ohms = 250 ÷ 7.5 = 33.4 amperes. This value of current would give sufficient starting torque for ordinary cases provided the field had full strength. With 33.4 amperes flowing in the circuit, the voltage drop across the resistance box would be 33.4 × 7 = 233.8 volts. This leaves 250 — 233.8 = 16.2 volts across the motor terminals, which would not give sufficient field strength to start the motor under any appreciable amount of load. To avoid this difficulty the field should be connected in series with a separate resistance box to the 250-volt circuit as in Fig. 2. The resistance value could then be adjusted to give normal field strength, which would remain constant regardless of the load conditions. The value of this resistance can be determined only after first measuring the field resistance. However, it will in all cases be of comparatively high value.

Disregarding the inefficiency of the scheme of using a resistance box in series with the armature for voltage control, there is an additional objection; namely, a change in speed if the load changes. Such a change would vary, depending on the character of the work the motor was doing. Under a condition of the load falling to such a value as to reduce the amperes to 10, then the voltage drop across the resistance box would be amperes × ohms = 10 × 7 = 70 volts. The voltage on the motor is 250 — 70 = 180 volts. This might cause the speed to rise to an undesirable value. If the load was removed entirely, the no-load current would be approximately 5 per cent of the normal load current, or one ampere. The voltage drop across the resistance box would then fall to 7 volts, giving 241 volts on the motor. The rise in speed might be of such value as to produce dangerous mechanical stresses in the armature, or pulley, and the commutator might also arc over. Under such a condition it would be necessary to insert more resistance in the armature circuit. At no-load conditions the resistance would be equal to volts drop across the resistance ÷ amperes = 140 ÷ 1 = 140 ohms. An adjusting feature would have to be provided in the resistance to change the values between 140 ohms and 7 ohms as the load came up to normal. This would require the constant attention of the operator, and in case of a belt flying off or breaking under full load the motor might be damaged before the operator could adjust the box. If the motor was connected by gears or direct-connected to a shaft driving a pump or similar load, then as the speed increased the load would increase also, which would tend to keep the speed from reaching an excessive value. The actual increase of speed in such a case would depend on the character of the work and would lessen to a certain extent the need of the operator's attention. Under such conditions it should be kept in mind that this arrangement is generally anything but satisfactory.

Frequently, direct-acting pumps will be found that have been short-stroking for long periods owing to improper valve setting or too tight packing. This may result in badly worn rods, valve stems or shoulders in the cylinder. Occasional inspection of the pumps is as necessary as other equipment in the plant.

Co-operation

A Straightforward Talk to the Operating Engineer and the Manager

By J. M. SULLIVAN†

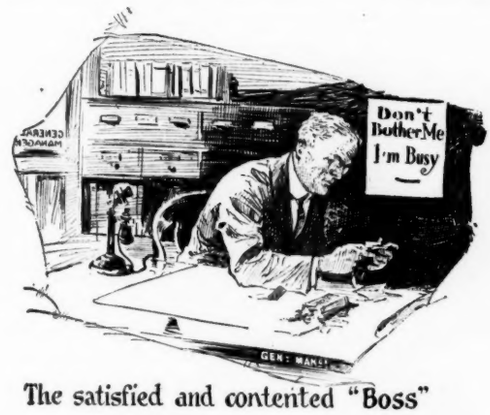
IN TOO many power plants, there is lack of co-operation between the "boss" and the engineer. This is to be regretted because of all the men in the organization these two should most thoroughly understand each other and be in most perfect accord. By the "boss" I mean the man who is held accountable for the operation of the plant as a whole, the man who makes decisions with regard to operating expenditures, policy of concern, etc., whether he be the actual owner or a man hired for the purpose. He is variously known as manager, superintendent, etc., but whatever his title, he is the poor devil who is jerked on the carpet when the profits begin to show up on the wrong side of the ledger.

The engineer is frequently as much to blame for this state of affairs as is the "boss." The "boss" is allotting the money to operate the plant, and the engineer should endeavor to make it go as far and to as good a purpose as his knowledge, experience and common sense will allow.

To these two men, then, the "boss" and the engineer, I say, "GET TOGETHER" (the sooner the better) and study the needs of your plant in a business-like way because the time has arrived—and has been here for some time—when real economy must be obtained in all departments of a plant if competition is to be met. Some day I will write up an indictment of "swivel chair" engineers, and their cause, "satisfied and contented bosses," but for the present I will limit myself to the co-operation there should be between these two men. Being an engineer myself, I will "rag" the engineer first, and if I can get him real mad, it will keep him for a while from brooding over the fact that he is an engineer, besides giving him something to think about.

The "Swivel chair" engineer

In the first place, don't be afraid of the "front office." Walk right in whenever you get a money-saving idea; there is not a case on record of an engineer being killed for coming to the office on any other day than payday. Take the "boss" down to the job and explain your idea to him. Have your data in such shape that you can give a reasonably close estimate of what the saving would amount to in dollars and cents or in percentage on the investment in case the idea or suggestion is adopted. Don't become disgusted if you fail. Keep it up, and keep it up all the time. Show that you are



The satisfied and contented "Boss"

interested in your job and in the plant's making money. Take an interest in all activities about the plant. Don't be afraid to "nib in." If ice, coal or some other commodity is handled in a costly manner, give the "boss" the facts as you see them.

Don't try out every new thing that comes along. Investigate and get sure dope on any new appliance before recommending its installation. Keep up this line of endeavor and after a while you will notice that you are being consulted by the "boss" more often than before—especially if you have put over a few little money savers—and that some attention is being paid to your ability as an engineer. If, however, you are a "swivel-chair boy" who avoids the "boss" at every opportunity, don't be disgruntled if everything you get is recommended by a consulting engineer. Just hold down your chair and smoke in peace.

Keep posted. Subscribe for the best technical journals in your line of work, don't stop at subscribing—read the papers and *study* them, apply what you learn, know your actual cost of production and know it before the office jumps your collar. Beat them to it and be able to explain why it is so. A simple system of records and time keeping will do the trick. If you go in for records, however, don't go "record mad," because the thing can be overdone. During a visit to a large institute recently, I saw a case in point. In addition to an efficiency engineer they had a force of four clerks whose whole time was taken up in sorting, classifying and recording the data turned in to them each day on a mass of record sheets from their 1,000-hp. plant.

You can imagine about how much of the plant employees' time was squandered in gathering this "evidence" of thousands of items of temperature, pressure, amperage, voltage, speed and gravity. About the only things they missed, according to a boiler-room wit, were the fingerprints of the hands on the punch clock. Here was a case of a chief engineer gone "record-loco,"

†Chief engineer, Culver Academy, Culver, Indiana.

and I was forced to think their efficiency was costing them some good money.

Don't have men wasting valuable time looking up and recording items of temperature and pressure that are not *vital*. Learn the items that will give the desired information and have them recorded religiously. Recording instruments save time and should not be overlooked in this connection. Whatever records you have, make them short, to the point, keeping them year after year for comparison purposes.

The boiler room being the heart of all steam plants and the real source of power, you should give it the

Don't be afraid to "Nib in"

attention to which it is entitled. The amount of CO_2 in the waste gases from your furnace is of far more importance, in my opinion, than the specific gravity of the brine, on which subject a controversy raged for about a year between two big men in the refrigerating world.

I believe also in paying more attention to raising the CO_2 than to the argument as to just where the frost should stop on the suction line. Boost your CO_2 a few more notches and it will silence a multitude of imaginary clearance-space troubles. If one-fourth of the time that is spent now in making fool tools and improvised appliances out of gas pipes and fittings were utilized in trying to raise the boiler efficiency, we would not find so many cases of 5 per cent CO_2. Neither would so many embryo inventors "make the line" so often in their favorite journals. In the past great attention has been paid to small improvements and experiments in the engine room, whereas little or no engineering attention has been given to the real "prime mover" in the boiler room. It is an easy matter to find out if the compressors and auxiliaries are using steam efficiently, but not so easy or desirable a job for some engineers to discover whether the boiler is *making* the steam efficiently. Nine times out of ten, where you are burning too much coal per unit of output, the trouble lies in the furnaces or boilers.

We have been stingy with steam for the main engines and auxiliaries mainly because the boilers were not in a position to generate it efficiently, and we have had to make what steam we could get from the boilers—mighty little for the amount of coal burned—go as far as possible. I have seen many an engineer, after his boiler plant had been brought to life, begin to sit up and take notice himself and start to take an interest in an "Orsat" as well as a steam-engine indicator. I have also noticed that if the new love lasts for a year it generally "takes." However, some alleged engineers tire of combustion efficiency very easily. If you call on them six months after their plant has been outfitted with CO_2 apparatus, you will find them back in the old swivel chair and the gas collectors and instruments covered with dust behind the boilers. These fellows are "marked for rest" and deserve no further consideration.

If you weigh the coal and meter the feed water you use and know the percentage of moisture and ash and the B.t.u. per pound of the coal you are firing, you can get a pretty good line on the efficiency of furnaces, boilers and fireman. Everything depends on the fireman, and the main thing is to get him interested in combustion efficiency. To keep him interested, however, is another matter, as it so happens that there are firemen as well as engineers that are afflicted with the "dropsy." If a diagnosis shows that this ailment is too deep-seated in your fireman, the best thing to do is "drop" the brother from the payroll. I pay more attention to the selection of firemen than of any other men about the plant and require all watch engineers to graduate from the boiler room. The fireman is charged with increasing the CO_2 and decreasing the CO in the waste gases, and he must do this with as little excess air as possible. It is a ticklish job this fireman has, and he should be given all the assistance and encouragement possible in the way of instruments and advice to enable him to see the "dead lines" and guide his way between them. If the air supply is cut down too much, the percentage of CO will rise and a gas of high heat content will pass up the chimney unburned. With a well-designed furnace there is little danger of CO escaping while the CO_2 averages 15 per cent or less. Above 15 per cent CO_2, however, you are treading dangerous ground, and frequent tests for CO should be made. Suppose you have a plant operating 300 days a year and burning 20 tons a day of 13,500-B.t.u. coal, under such furnace conditions that the flue gases weigh 18 lb. per pound of coal burned. Suppose further, that

It will not do to call all hands on the carpet and read the riot act----

the CO averages only 1 per cent for the whole year. By reducing this CO to zero you can save during the year about 400 tons of coal, which is a big item these days.

Look around and decide what your plant needs most and then make a business-like effort to get it. You don't have to stand on combustion apparatus alone. There are several other methods of trapping the elusive B.t.u. and putting it to work. Among these I might mention the following: Feed-water heaters, waste-

gas economizers, feed-water regulators, damper regulators, balanced-draft equipment and superheat. Don't forget superheat. It is coming and coming fast to all except very small plants. Post yourself on its advantages and have the answer when the "boss" asks about it. And again, before I go after your "boss," let me say, don't be afraid of him, he is no "Jack Dempsey." He won't knock you down if you come on a business call. In fact 99 per cent of the "bosses" want you to talk business with them. They also want a man who knows what the plant needs and who has the "guts" to ask for it.

Most Managers Are Contented

Mr. Manager, while lambasting your engineer a few moments ago, I mentioned the fact that most managers were satisfied and contented. If they were not, we would have them preaching economy every day in the month instead of becoming overzealous for a few days only, just after the monthly report appears, and then losing interest again for another thirty days. *Somebody* connected with the plant must take the initiative and wade into this economy business and keep constantly at it. Whoever it is should not stop half way. He must be on the job all the time with his eyes open.

It will not do to call all hands on the carpet once a month and read the riot act to all concerned. This has little effect and the crew soon become calloused to such procedure and are back in the old rut in a few days. If you don't show that you are interested in the plant and its economical operation, you cannot blame the crew for the high costs; they are not stockholders in the business, and they will not go to any extra trouble unless someone who cares and is interested goes right along with them.

I have always contended that it was the manager's place to take the initiative in this respect, but I am sorry to say that in the majority of cases it is usually the engineer who comes to the front with suggestions as to a cheaper operation. When he is fortunate enough to be with a manager who will co-operate with him, you will nearly always find an efficient plant. I am pained to record, however, that in my twenty-six years' experience as an erecting and operating engineer, I have found few cases of perfect co-operation between the engineer and manager. If such co-operation had existed, the expert's services would not have been required in straightening out many a plant. The manager and the engineer would have gotten together and gone to the bottom of the trouble themselves. Talk to the manager in a case of this kind and he will tell you his engineer is a numbskull, etc., and ask you to recommend another man. Quiz the engineer and you will find, nine times out of ten, that he knew the conditions of affairs for some time, but could not induce the manager "to spend some money at the time it was needed, etc." And there you are, they are at loggerheads, passing the buck, and *somebody* is paying an outsider "so much per and expenses" to bring the plant up to its proper capacity.

Listen to the Engineer's Suggestions

Get together, I say. If your engineer comes in with a suggestion, "be from Missouri" for a while and make him "show" you that it will do what he claims. If it is successful, you will see him come again and you will also notice, if you are a wise manager, that time spent in this manner pays very well. Yes, it is returned with interest. On the other hand, if you throw the wet blanket on everything the man suggests, don't blame him if he loses interest in his job.

Twenty years ago engineers had to buy, out of their own salaries, what instruments they required about the plant for testing purposes. Of course, it is a shame that they had to do so, but it is a fact nevertheless. When the steam-engine indicator first appeared, the manufacturers would have starved to death if plant owners had been the only buyers. Likewise when combustion apparatus was in its swaddling clothes, the engineers of the country bought up the outfit of misfit draft gages and "Orsats" in an endeavor to improve their plants and save money for a manager or owner who could not or would not see. Today they do not have to do this. First-class instruments for any purpose are now obtainable, and they should be bought by the owner, the same as tools or fuel.

Some Examples of Poor Management

I could give many cases in point and "horrible examples" along these lines, but will confine myself to a few only. About fifteen years ago I took charge of a combination central station, ice and refrigerating plant that was burning thirteen tons of $3 Illinois coal per watch of eight hours. The records showed that they had averaged close to forty tons of coal a day for five and one-half years. That was standard operation there; everybody was satisfied and happy from the president down to the man whom I was relieving. He was being promoted, in fact, to take charge of a larger plant. His only regret in leaving at that time was that he had not completed plans for an elaborate coal- and ash-handling system for the plant. They had in the boiler room one fireman, one helper, one coal passer and an ash wheeler on each watch. The boiler room was a workhouse and I knew coal was being wasted. A requisition for a simple gas collector and a gas analyzer was turned down, so I bought the apparatus with the understanding that if I could get the results I claimed, the company would take it off my hands, besides paying me a bonus on the coal saved.

To cut a long story short, on the twenty-ninth day after taking charge they were burning eight tons of coal per shift and using three less men per day in the boiler room. After this "knockout" they took great interest in my suggestions, and a few months later we changed the furnaces to use slack coal at $1.50 per ton instead of the $3 run-of-mine, with a further saving of half the coal money. Besides, the ash and coal handling now ceased to be a problem, and we used the appropriation made for that purpose on the stoker installation.

Here was a plant where no fault could be found with the steam consumption or operation of the engine-room apparatus, but they had a dead line drawn at the boiler-room door. Nobody was interested in that part of the plant, yet a little application of the correct principles cut the coal bill from $120 to $36 per day, which in turn reduced the boiler-room help.

Selecting the Working Force

In ice-plant management a great deal of attention should be given to the selection of the force in boiler, engine and tank rooms. Above all the chief engineer and boiler-room operators should know their business. The engineer should be a man of both operating and executive ability. I am laying stress on his department

because what losses can occur in the sales and delivery end, through stealing, shrinkage, etc., are petit larcency compared with the losses that can happen in the ice-manufacturing department. Your chief engineer should be first of all practical, possessing enough theory to figure out the engineering problems involved and apply the results to the plant in his charge. Besides, he should be acquainted with ordinary business procedure and on speaking terms with costs, and he should be able to see the different activities of his plant in their true relation. The engineer, whom you are holding responsible for the efficiency of the plant, should be consulted when supplies and materials are purchased so

CO_2 SCHEDULE FOR FIREMEN

Per Cent CO_2	Preventable Fuel Loss, per Cent	Excess Air to Furnace, per Cent	Fireman's Bonus per Shift
15	0.0	38	$1.00
14	0.8	48	.90
13	1.8	59	.80
12	2.8	72	.70
11	4.1	88	.60
10	5.7	107	.50
9	7.6	130	.40
8	9.7	159	.30
7	13.0	196	.20
6	17.1	245	.....
5	22.8	314	.....
4	31.2	417	.....
3	45.3	590	.....
2	74.0	935	.....
1	....	1,970	.....

A bonus will be paid each fireman, each shift, if the flue gas sample from his shift tests 7 per cent or over.

Bonuses are as shown in the above table, and begin with 20 cents for 7 per cent CO_2 and range up to $1 for 15 per cent CO_2 or over.

The gas collector takes a continuous sample of flue gas during each shift, which will be tested at the end of each shift and the results posted on board in boiler room.

The boiler setting is as near tight as we can get it, so it is up to *you firemen* to let just the right amount of air get into the combustion chamber, *through the fires.* This can be done by watching the draft and keeping all holes filled on the grates. Fire light and often instead of using thick fires with the danger of *too much air* rushing in when fires are broken up.

Causes of Low CO_2 are:

(A) Leaky boiler setting.
(B) Too much draft.
(C) Too thin a fire.
(D) A fire in which holes have been allowed to burn.

Causes of Incomplete Combustion, Resulting in the Formation of CO are:

(A) Too thick a fire bed or bed of ash.
(B) Insufficient draft.
(C) Grates sealed by clinkers or ash.
(D) Too thick a bed of fresh coal.

Study the above table and remember that when you are making only 7 per cent CO_2 you are allowing about 200 per cent *too much* air to enter the furnace and that 13 *per cent of the fuel is being wasted.* On the other hand, if you cut down the air supply too much, CO is formed and escapes up the chimney unburned. Work to raise the CO_2 and lower the CO and we will give you part of the savings.

that not only may you profit by his advice and experience, but he may operate the plant more efficiently.

Too often supplies, materials and fuel are purchased by a clerk wholly upon the basis of the "price quoted" without any regard to the requirements. As this is a great handicap to an engineer who is trying to do the right thing, I will illustrate it with an actual occurrence that came to my notice while "shooting trouble" in a large packing plant. The feed water was a mixture of Kansas and Missouri river waters which deposited a heavy scale in the boilers, necessitating spare units and frequent cleaning. The purchasing agent at the home office had bought for the plant 24 bbl. of compound, which had been at the plant for six months and which the engineer refused to use. The compound salesman was after the purchasing agent for a testimonial, and the purchasing agent was after the engineer to use the stuff. Finally, the engineer said he would try the compound only on orders from the general superintendent or supervising engineer, protesting all the time that the boilers would be burned. The order came through in the course of a week, and before the end of another week nine of their eighteen boilers were down with "bags." If it had not been for a community steam connection from the other plants in the yards, this particular one would have had to shut down.

Conservation of fuel should be of vital interest to all managers and owners of plants no matter whether they are actuated by patriotism or by self-interest. Fuel is by far the greatest item of expense in any plant, and it should be given proper attention because, as I said before, competition is going to be keen in the future and every scheme of resourceful Americans will be needed in the game.

The purpose of this talk has been to show the importance of co-operation in the business of running a power plant. As already stated, the boiler room is one of the places where such co-operation is essential. A notice similar to one shown on this page, posted in the boiler room and backed up by the chief engineer, should prove helpful to this end. This is given as just one illustration out of hundreds of things that may be worth doing.

In sampling flue gases by the two-bottle method it is sometimes of interest to know what chance there is of serious errors due to the absorption of the various constituent gases by the water. At a temperature of 60 deg. F. and with a single pure gas in contact with water, 100 volumes of water will absorb approximately 107 volumes of CO_2, 4 volumes of oxygen, 2 volumes of nitrogen or 3 volumes of CO. It is only in the case of CO_2 that this absorption is of importance in ordinary power-plant work. If a flue gas contained 11 per cent of CO_2 each 100 volumes of water could absorb 11.8 volumes of CO_2 if sufficient time were allowed. This figure was obtained by taking 11 per cent of the 107 volumes that would be absorbed if pure CO_2 were in contact with the water. On this account a sample of flue gas collected over fresh water and allowed to stand will show an appreciable reduction in CO_2 and the subsequent analysis will not be fair to the boiler.

It is a frequent practice to heat large tanks of water by bubbling steam into the water. If the steam is not fed too rapidly, and if the temperature of the water is not raised too close to the boiling point, the heating efficiency of the steam may be nearly 100 per cent. For rough and rapid estimates of the amount of steam required the number of pounds of water to be heated is multiplied by the temperature rise and the product divided by 1,000. The latter figure is, of course, a round number representing the heat given up by one pound of steam in condensing. The pressure of the steam has little effect on the weight required.

Examination of numerous tests on steam turbines and Diesel-engine plants shows that the average thermal efficiency of the largest steam-turbine central station is less than 20 per cent, while the efficiency of Diesel plants with a load factor of 40 per cent is over 25 per cent and for load factors of 70 per cent the efficiency runs as high as 32 per cent. The efficiency of the reciprocating steam-engine plants seldom exceeds 10 or 12 per cent. The first costs of the large steam turbine and of the Diesel plants are on a parity.

Solving Refrigerating Problems by the Total Heat Diagram

IN THE refrigerating plant many problems arise which for solution require a considerable amount of mathematical calculations. Much of the hard work accompanying the use of mathematics in these problems can be eliminated by making use of the Mollier Diagram or Total Heat Chart. Such a chart, based on Goodenough's table of the properties of ammonia, is shown in Fig. 1. Here the vertical scale shows the total number of British thermal units in a pound of ammonia under various conditions of liquid, saturation vapor and superheat. The diagonal lines show values of entropy, this being a function of heat which has been called the heat-weight, and which remains constant as long as heat is neither added nor taken away as heat, as in adiabatic compression or expansion. The line *AB* is called the liquid line and gives the heat in a pound of liquid ammonia at various pressures. The boiling temperatures corresponding to these pressures appear in the table in Fig. 1. The line marked "saturation line" gives the total heat in a pound of ammonia when evaporated and in a dry saturated condition at various pressures and temperatures; the numbers along this curve are the pressures indicated by the diagonal lines radiating from the liquid line. As an example, at 9 lb. absolute pressure (—6 lb. gage) the heat in a pound of saturated ammonia vapor, by reading horizontally through the intersection of the 9-lb. pressure line with the saturation line, is found to be 525 B.t.u. The continuation of the pressure lines above the saturation line shows the further addition of heat causes the ammonia to become superheated, and at any temperature the total heat in B.t.u. is read by moving horizontally to the side of the chart.

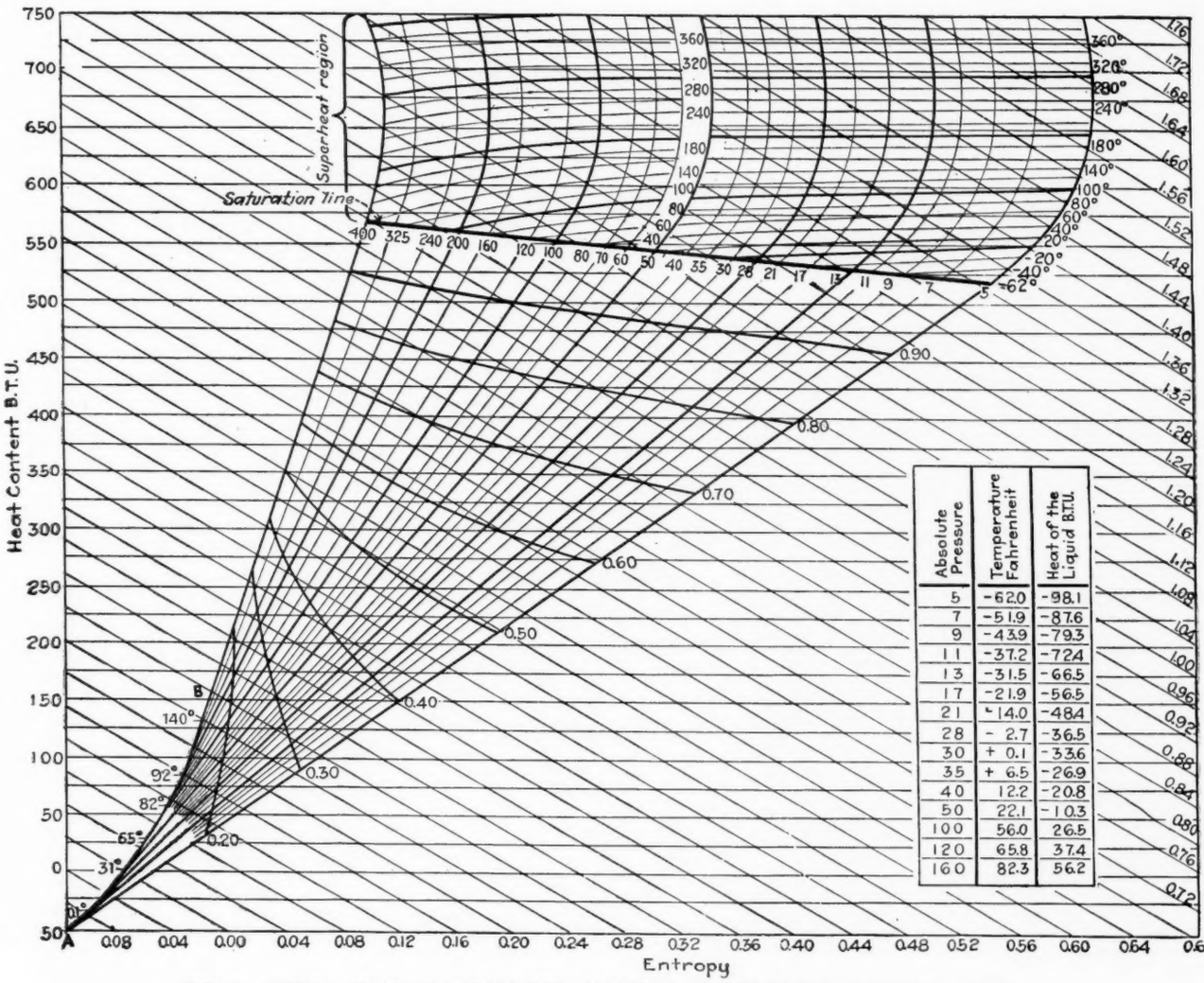


FIG. 1. TOTAL HEAT DIAGRAM FOR AMMONIA (FROM GOODENOUGH'S TABLES)

AMOUNT OF AMMONIA CIRCULATED

To illustrate the value of this kind of chart, suppose a plant was operating under a suction pressure of 30 lb. absolute (15 lb. gage) with the ammonia coming to the compressor dry saturated, and having a discharge or head pressure of 160 lb. absolute (145 lb. gage) with a

condenser temperature of 70 deg. It is desired to know the amount of ammonia necessary to circulate to produce 100 tons of refrigeration (a ton of refrigeration is the removal of 200 B.t.u. per minute, 100 tons being the removal of 20,000 B.t.u. per minute). The temperature of the liquid ammonia in the receiver is as stated, 70 deg. and its condition is shown by the point *B'*, Fig. 2.

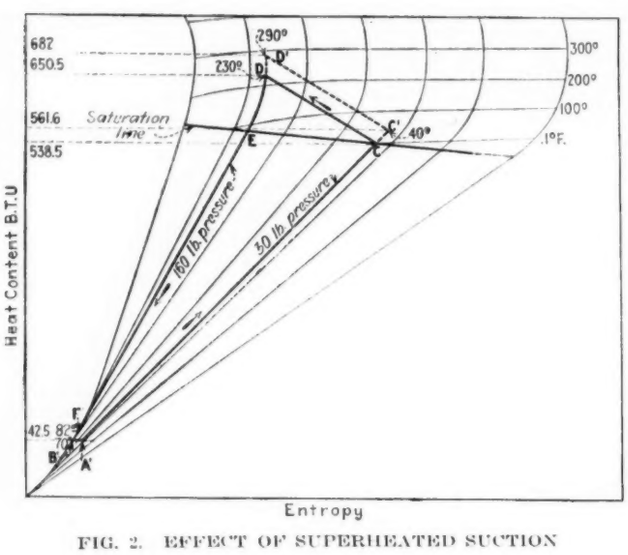


FIG. 2. EFFECT OF SUPERHEATED SUCTION

In passing through the expansion valve, the amount of heat in the ammonia is not changed, but the pressure is reduced from 160 lb. to 30 lb. Starting at 70 deg. on the liquid line, as outlined in Fig. 2, moving the pencil horizontally at equal heat to 30 lb. gives the condition of the ammonia when entering the coils. Practically no heat is lost or gained in the passage through the valve, consequently the total heat after passage is equal to the heat in the ammonia as it enters the valve. It has, as before, 42.5 B.t.u., but in passing through the valve some of the liquid evaporated into vapor. By tracing this process on Fig. 1 it is apparent that 22 per cent of the ammonia flashes into vapor in passing the valve and its condition is represented by *A'*. But the heat is the same as in the receiver; namely, 42.5 B.t.u. In evaporating in the coil at the boiling temperature of zero degrees Fahrenheit, the condition of the ammonia follows the 30-lb. line in Fig. 2 until the ammonia is entirely evaporated, being in the condition represented by the intersection of the 30-lb. line with the saturation line at *C*. At this point the ammonia now contains, as read from the horizontal line to the side, 538.5 B.t.u. The heat absorbed by the ammonia is the difference between 538.5 and 42.5, or 496 B.t.u. To handle 20,000 B.t.u., or 100 tons of refrigeration, would require 20,000 ÷ 496, or 40.3 lb. of ammonia per minute. Fig. 2 is too small to use in determining values, but the events can be followed easily and the exact values secured from the chart shown in Fig. 1.

Compressor Duty

It is now desirable to find the work required by the compressor to raise one pound of ammonia vapor from 30 lb. absolute dry saturated to 160 lb. absolute head pressure. As noted heretofore, the entropy of the vapor remains constant during an adiabatic compression. In an ammonia compressor the compression is almost adiabatic; that is, no heat is absorbed by the gas from the outside. Consequently, we should follow the diagonal entropy line from 30 lb. until this line intersects the 160-lb. pressure line at *D*. The vapor, which is now superheated 148 deg. and is at a temperature of 230 deg. F., as indicated by the intersection of the 160-lb. pressure line with the 230-deg. temperature curve. The discharge gases now contain 650.5 B.t.u. The work of compression is the heat after compression minus the heat in the suction vapor or 650.5 — 538.5 = 112 B.t.u. Since one B.t.u. = 778 ft.-lb., to compress one pound of ammonia under conditions given would require 114 × 778 = 87,136 ft.-lb., or 2.64 hp. Since the compressor efficiency is about 75 per cent, 3.52 hp. input would be required.

Superheat in the Suction

Usually, the suction vapor does not reach the compressor cylinder in a saturated condition; that is, its temperature is above the boiling temperature for the pressure carried. Part of this superheat occurs before the vapor reaches the compressor, due to heat absorption in the line. This has done no useful work, so the refrigerating duty is the same as before. The work of the compressor, however, is increased. In Fig. 2 the dotted line shows the ammonia coming to the compressor not saturated as at *C*, but superheated 40 deg. as at *C'*. It contains 561.6 B.t.u. and after being compressed along *C'D'* is discharged at a temperature of 290 deg. and contains 682 B.t.u. The compressor work is 183 —561.6, or 121.4 B.t.u. instead of 93 B.t.u. as with saturated vapor. This shows the advantage of keeping the suction vapor as near saturated as possible.

Condenser Duty

While usually sufficient cooling water is available, still in providing for ample pumping facilities it is advisable to ascertain the heat to be removed by the

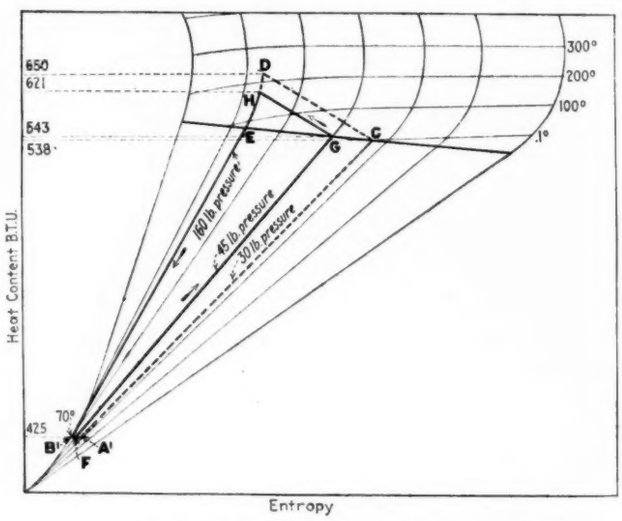


FIG. 3. EFFECT OF LOW SUCTION PRESSURES

condenser cooling water. Taking the same conditions as before—that is, 30 lb. saturated suction and 160 lb. discharge pressure—it has been found that the discharge is superheated 148 deg. and contains 650.5 B.t.u. per pound of ammonia. The ammonia is liquefied by cooling, the first action being the removal of the superheat. In this removal the condition changes from *D* to *E*, where the temperature is 82.3 deg., correspond-

ing to 160 lb. pressure and requiring the elimination of 650.5 — 557.5 = 93 B.t.u. In liquefying, the condition moves from *E* along the 160-lb. pressure line at the same temperature of 82.3 deg. to *F*, where all the vapor has condensed and is still at a temperature of 82.3 deg. F. Further cooling lowers the temperature to 70 deg., where the heat left in the ammonia liquid is 42.5 B.t.u. In the superheated condition the ammonia contained 650.5 B.t.u. and at 70 deg. it contains 42.5. The difference of 608 B.t.u. must be removed by the cooling water. If the water enters at 65 deg. and leaves at 90 deg., there is a temperature rise of 15 deg. Since the heat necessary to raise one pound of water one degree is 1 B.t.u., 608 ÷ 15 = 40 lb. of water is required per pound of ammonia circulated. Any condition of ammonia and water can be used, and the water required can be determined by the use of the chart.

Loss from Low Suction Pressures

In many plants lower suction pressures and corresponding temperatures than absolutely necessary are carried in the evaporating coils. A study of the heat diagram will speedily correct anyone who is under the impression that low suction pressures reduce the compression load. While using 30 lb. as the suction pressure in the previous example, the discharge pressure was 160 lb. The heat removed from the cold-storage system was 496 B.t.u., and the work done by the compressor was found to be 11.2 B.t.u.

Let the suction pressure be 45 lb. absolute (30 lb. gage) instead of 30 lb. absolute. The ammonia in the receiver is at 70 deg. temperature and contains 42.5 B.t.u. as before. In passing through the expansion valve into the coils, which are at 45 lb. absolute pressure, the heat of the ammonia remains at 42.5 B.t.u. and reaches the coil in the condition represented by *F* in Fig. 3. In evaporating, the ammonia absorbs heat and arrives at the compressor in a saturated condition represented by *G*, Fig. 3. It now contains 543.1 B.t.u. and has absorbed 543.1 — 42.5 = 500.6 B.t.u. from the coils.

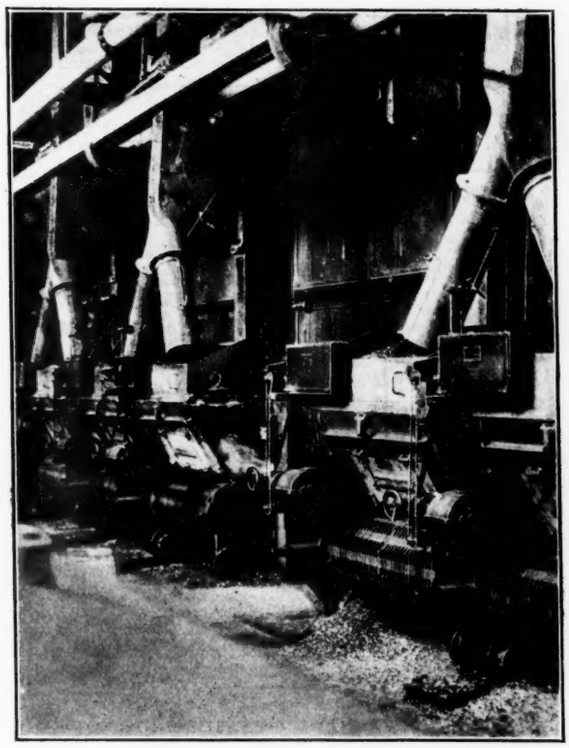
After being compressed to 160 lb. discharge pressure, the ammonia leaves the compressor at the point *H* and is at a temperature of 180 deg. and contains 621.6 B.t.u. The compressor has added 621.6 — 543.1 = 78.3 B.t.u. With 30 lb. suction the compressor added 112 B.t.u., while the evaporating coils added 496 B.t.u., or 4.43 B.t.u. of refrigerating for each B.t.u. of work done by the compressors. But when using 45 lb. suction the ratio is $\frac{5006}{78.3}$ or 6.27. From this it is apparent that if the higher suction pressure can be carried, the work of compression is much less than with 30 lb. suction.

Long Discharge

Recently, the question was raised by the engineer of a 50-ton plant as to what effect a long discharge line would have. In this plant the condenser was placed approximately 200 ft. from the compressor. The pipe was of small diameter, and this combined with a large number of fittings caused the pressure drop between the compressor and condenser to be 40 lb. The cooling water was such that 160 lb. absolute (145 lb. gage) condenser pressure was necessary to cause liquefaction. The pressure at the compressor was 185 lb. gage, or 200 lb. absolute. The heat added by the compressor to 160 lb. from 30 lb. suction pressure is found from Fig. 1 to be 650 — 538, or 112 B.t.u. per pound of ammonia handled. This is the work that would have been done if the compressor discharge pressure were equal to the condenser pressure with no drop in the line. The heat in the ammonia after compression to 200 lb. is from Fig. 1, following the constant entropy line from 30 lb. to 200 lb. where the discharge temperature is 260 deg., 665.5 B.t.u. At 30 lb. the ammonia contains 538.5 B.t.u. The work of compression to 200 lb. is 665.5 — 538.5 = 127 B.t.u. The increased work due to the high discharge is 127 — 112, or 15 B.t.u. This is 13 per cent of the total work of compression. In other words, by proper size piping or by locating the condenser within reasonable distance, the cost of power for the plant would be reduced 12 to 13 per cent.

Meters Coal Within 2½ Per Cent.

The measuring of the amount of steam generation in the boiler has been made comparatively easy through the introduction of a number of steam-flow meters. Likewise, the feed water is measured by meters, both of the turbine and weir type. The accurate measuring of the coal fired has heretofore been secured through the use of weighing scales of the automatic hopper type.



LEA COAL METER

A new coal meter has been built by the Lea Recording Co., Ltd., and is in use in Great Britain where its accuracy on test has been within 2½ per cent. The meter as installed at the Edinburgh Electric Works is shown in the illustration.

The meter, which operates on the volume of flow principle, measures the flow of coal in the down spout to the stoker, and as the weight of coal per cubic foot is fairly constant, the error is held within the percentage mentioned.

Wrecking Compound Engines

By W. H. WAKEMAN

THE following is not the report of an actual accident, but it calls attention to what could happen and undoubtedly has happened under given conditions. The first move in starting a compound engine is to drain water out of the live-steam pipe and admit steam to warm both cylinders. If the throttle valve is fitted with a bypass, it should be used for this purpose, as that is better than cracking the main valve. If the valve gear is of the four-valve type, the valves may be operated by hand for the purpose of blowing steam through to the condenser. With the ordinary Corliss gear it becomes necessary to rock the wristplate and admit steam to each end alternately.

The independent condensing apparatus is started, and the gage shows a vacuum of 20 in. As each pound of air is equal to 2.04 in., it shows that $20 \div 2.04 = 9.8$ lb. of the atmospheric back pressure has been removed, leaving an actual pressure of 5 lb. in the condenser. All pressures in this case are absolute, or above zero.

Having completed this operation, the valve gear is hooked up and enough steam is admitted to start the engine. Assume that 25 lb. is sufficient for this purpose, and as there is no cut-off at this speed, full pressure is maintained to the end of the stroke.

Fig. 1 shows the piston of the high-pressure side. It has completed the outward stroke and has begun its return stroke, as indicated by the arrow. The low-pressure cylinder is twice the diameter of the high, therefore its volume is four times as great. If steam was discharged directly to the low-pressure cylinder, the pressure would not exceed 6 lb., but with a cross-compound engine the space due to the receiver and its connections causes further expansion of the steam, hence the terminal pressure would not exceed 4 lb. and it might be less.

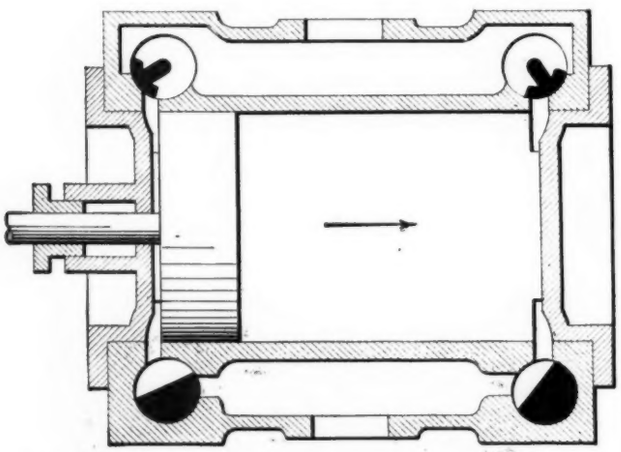


FIG. 1. POSITION OF HIGH-PRESSURE PISTON AND VALVES AT END OF STROKE

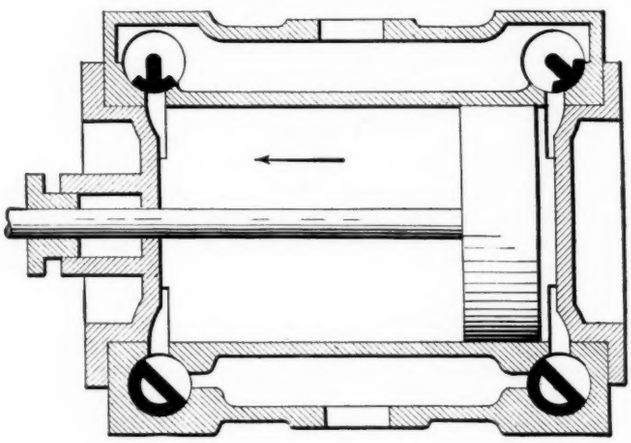


FIG. 2. LOW-PRESSURE CYLINDER RECEIVING STEAM FOR FORWARD STROKE

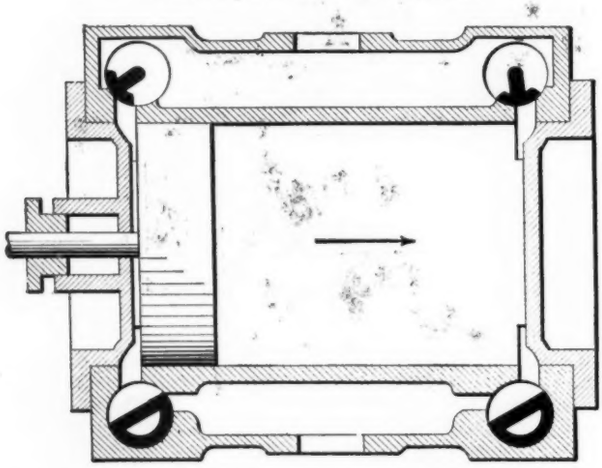


FIG. 3. BEGINNING OF LOW-PRESSURE PISTON RETURN STROKE

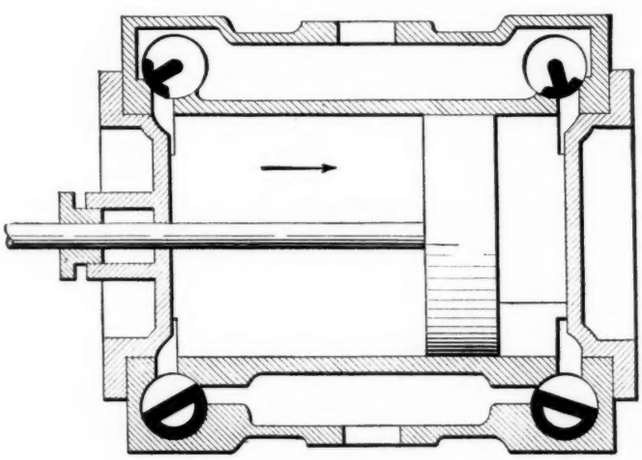


FIG. 4. SHOWING WATER TRAPPED ABOVE EXHAUST VALVE

Fig. 2 shows the low-pressure cylinder receiving this steam, with the piston beginning its forward stroke, as indicated by the arrow. Fig. 3 illustrates the beginning of the return stroke with the exhaust valve open to the condenser. There is less than 4 lb. pressure in the cylinder with 5 lb. in the condenser, consequently water is forced into the cylinder. It is necessary to close the exhaust valve early in the return stroke in order to secure proper compression pressure, therefore this

water is trapped in the cylinder as illustrated in Fig. 4. Steam acting on the high-pressure piston, assisted by more or less momentum of the flywheel, forces this piston to the end of its stroke, but in order to do this the cylinder head must be forced out and other parts may be bent or broken, thus completing the wreck.

A certain cross-compound engine was wrecked while starting up under such a condition, but the engineer claimed that this extremely high compression pressure forced the steam valve from its seat. This suddenly relieved the pressure under it, and the valve was thrown to its seat with sufficient force to break it. One of the pieces was caught in the port and broke the cylinder. It is difficult to prove such theories.

In another case the low-pressure cylinder was wrecked while shutting down. The engineer claimed that it was stopped strictly in accordance with common practice. Salt water for condensing purposes was drawn from the harbor, and when the wreck was examined, seaweed was found in the broken cylinder. This proved that the accident was not caused by water coming over from the high-pressure cylinder.

If the injection water is shut off by means of a gate valve, or if there is a lower pressure in the condenser than in the low-pressure cylinder, such an accident will not happen.

Converting a Direct-Current Generator Into a Motor

BY EUSTIS H. THOMPSON

If a shunt-wound generator is operating in multiple with other machines and the power is gradually cut off from the prime mover, as would happen by gradually throttling down on the steam of an engine, the generator would supply less load and the current would gradually decrease until it reached the zero point, in which case the generator would be turning but not delivering power. If the steam is further turned off, the generator will take current from the busbars and will run

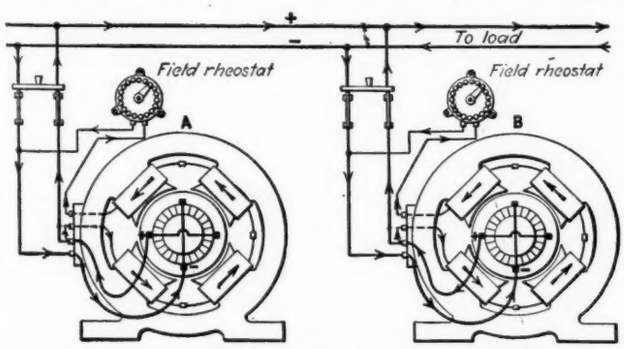


FIG. 1. TWO SHUNT GENERATORS CONNECTED IN PARALLEL; BOTH MACHINES ACTING AS GENERATORS

as a motor, causing the engine to revolve. This current will flow from the positive busbar into what was the positive terminal as a generator; that is, the current will flow through the armature in an opposite direction when operating as a motor as when running as a generator. This will be made clear by referring to Figs. 1 and 2. When both machines are operating as generators, as in Fig. 1, current flows from their positive terminals to the positive busbar, through the load and back to the negative terminals, as indicated by the arrowheads. Assume that machine *A* has been converted into a motor, as in Fig. 2, then current flows from the machine *B* into the positive busbar and then into the + terminal of machine *A* as indicated. In both cases it will be observed that current is in the same direction in the field winding. If a load could be applied on the motor, as by applying a brake to the engine's flywheel, it might be found that the motor would spark badly on account of the brushes being on the wrong side of the neutral. On machines without interpoles the brushes

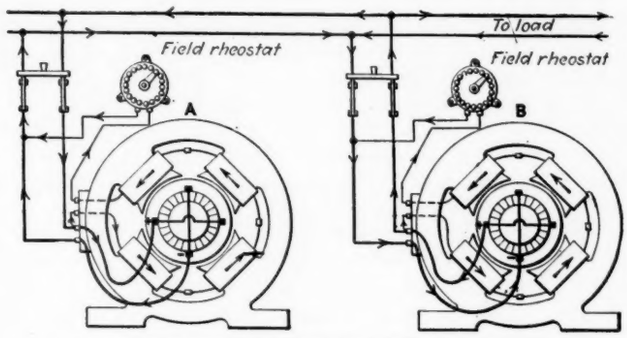


FIG. 2. TWO SHUNT GENERATORS CONNECTED IN PARALLEL; MACHINE *A* MOTORIZED

are frequently set back of the neutrals to improve commutation on a motor and ahead of the neutral on a generator.

If the generator were of the compound type, it would tend to speed up considerably when changed into a motor, on account of the current in the series-field winding changing its relation to the shunt field, thus weakening the flux in the polepieces. When the current flows back from the busbars through a generator, thus converting it into a motor, the current is reversed in the armature, but not in the shunt-field winding, as explained in Figs. 1 and 2. In a compound-wound machine, the series winding is in series with the armature. Consequently, the current in this winding will be reversed along with the armature current. On this account, before a compound generator can operate as a motor, the series-field leads will have to be interchanged.

The foregoing also holds true where a compound motor is converted into a generator. The series-field winding must be reversed or cut out of circuit, so that the machine will operate as a shunt generator. Where an elevator is lowering a heavy load, the motor acts as a generator and supplies power to the system. If the motor is of the compound type the series field is left in circuit only during the starting period. At all other times the machine is operating with a shunt-field winding only. This allows it to be converted readily into a generator when the elevator is lowering a heavy load. If the series-field winding were not cut out, this winding would have to be reversed before the machine could be effectively operated as a generator.

If the generator has interpoles, no bad effects will result when the machine is converted to a motor. The polarity of an interpole in either a generator or motor must be the same as the armature pole it is over. When the current reverses through the armature of the generator, it also reverses through the interpole winding. Consequently, the polarity relation between the armature and interpole remains the same. If a compensating winding is present, this need not be reversed when a machine is converted from a generator into a motor, except in cases where this winding is wound eccentrically to produce compounding.

Utilizing Flue Gases to Preheat Air to Furnace—Consideration of Some of the Problems Involved

By E. R. WELLES* and C. T. MITCHELL*

IN VIEW of the fact that the sensible heat of the flue gases represents such a large waste of fuel, it does not seem unreasonable to ask why it is not used to heat the air supply. A little reflection reveals the fact that it is mechanically possible to transfer practically all the heat from the flue gas to the air, provided we can afford to build a sufficiently large heat-transfer apparatus. Air and other gases require time in which to change their temperature. If we can keep up the heat-transfer operation long enough, we can recover the heat from the flue gas.

The problem is, therefore, an economic one, and our chief concern is to find how large an apparatus we can build and still obtain a reasonable return on the investment. The economizer has of course entered this field and become a more or less indispensable part of the equipment of certain boiler plants. The existence of the economizer does not of itself preclude the consideration of an air heater, however, since a large part of the work of an economizer consists in replacing the functions of the feed water, in itself an efficient type of apparatus. The usefulness of the economizer would be largely destroyed if it were used only to heat the boiler-feed water beyond the temperature limits of the feed water heater. It may be as well to state here, however, that the purpose of this article is merely to analyze, as clearly as possible and in an impartial manner, the possibilities of preheating air by means of flue gas and not to enter into premature comparisons between established types of apparatus and those of which we have little practical knowledge.

> It is a well-known fact that a large part of the heat in the coal fired to a boiler is wasted up the stack in the form of the sensible heat of the flue gases. There is nothing in the nature of things to prevent the use of these hot flue gases to preheat the air supply. The only question is whether money invested in a suitable preheating installation would yield a fair net return on the investment. This question is not susceptible of a definite answer until more experimental work has been done. However, rough preliminary calculations (the best that can be made with the available data) indicate a reasonable possibility of the economic application of preheating.

At this point it is pertinent to ask: "In what way will the economy manifest itself, supposing the heat-transfer problem has been solved and we have obtained a reliable circulation of preheated air?" The answer is, obviously, "In less coal per horsepower." The coal which originally preheated the air in the furnace is now no longer needed. The beginning of the cycle has been moved up a notch. In regard to the furnace control we have, as with cold air, the choice of two courses. We can reduce the quantity of air in proportion to the reduction in coal, thus raising the furnace temperatures and probably lowering the stack temperatures, or we can maintain conditions as they were before the use of preheated air; that is, use enough of the warm air to keep the furnace temperatures (and also the stack temperatures) unchanged. The first method might cause trouble with the refractories.

In the absence of experimental evidence we are helpless to decide between the two methods. It should be noted, however, that since we are in a position to vary the quantity of air per pound of coal, we cannot in fairness predict any particular furnace difficulties, except possibly a slight loss in equilibrium of temperature, requiring more careful regulation of the air supply. What evidence we have of preheating leads to no apprehension regarding furnace control. In the case of stokers we should expect a greater tendency to burn out the grates and tuyeres, increasing with the temperature of the air. This might be offset to a slight extent by the greater velocity of the warm air as it enters the tuyeres. Speculation as to this is a waste of time. With powdered coal, gas or oil fuel this danger would, of course, be eliminated. In fact, preheating and powdered coal would be mutually helpful, since the latter requires neither grates nor forced draft, while the economies due to successful preheating would immediately widen the field of powdered coal and silence much of the present controversy as to its relative merits.

The simplest way to determine the economical size of a preheater is to develop an expression for the efficiency of such a heater for varying capacity or heating surface. In doing so we will strive to make no assumptions that are not easily credible or that vary to any appreciable extent from known facts. We assume that the heat transferer consists of a sheet-metal container filled with steel tubes. The flue gas travels through the tubes and the cold air around the tubes, or vice versa, the flow being counter current in order to keep the temperature difference nearly constant. The weight of flue gas per hour will be taken the same as the weight of air. The specific heat of both gas and air will be taken as 0.25. The velocity of both air and gas with reference to the steel tube will be the same. On these assumptions, then, the temperature of any section of the steel tube will be a mean between the temperatures of the adjacent air and gas, and the following equation will be true for all practical purposes, neglecting radiation loss (which can be made negligible):

$$0.25\,WR = \tfrac{1}{2}AK[(T_g - \tfrac{1}{2}R) - (T_a + \tfrac{1}{2}R)]$$

in which

W = Pounds of air (or gas) per hour;
R = Total temperature rise of air (or drop of gas) in degrees F.;
A = Heating surface of the preheater, in square feet;
T_g = Initial gas temperature, degrees F.;
T_a = Initial air temperature, degrees F.;
K = Heat transfer rate in B.t.u. per square feet per hour per degree temperature difference

(*) Mechanical Division, The J. G. White Engineering Corporation.

between the surface of the tube and the adjacent air (or gas).[1]

Whence

$$R = \frac{T_g - T_a}{\frac{W}{2AK} + 1}$$

and the efficiency of the heater becomes

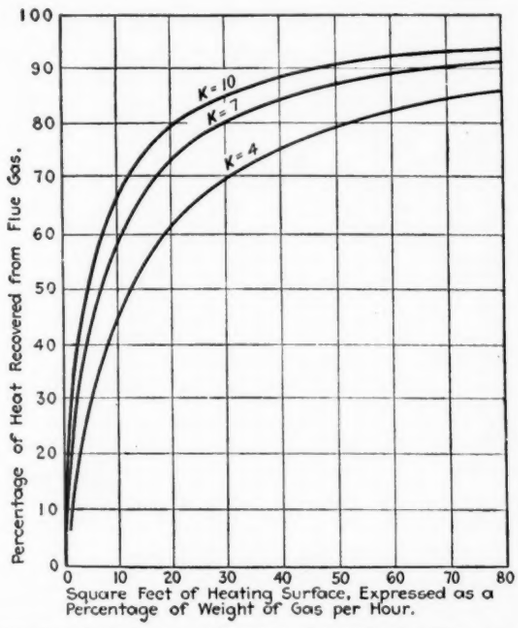
$$\text{Efficiency} = \frac{1}{\frac{W}{2AK} + 1}$$

It is readily seen from this formula that an extraordinarily large heating surface would result in an efficiency approximating 100 per cent, which means that the air would be preheated to the temperature of the flue gas, neglecting radiation losses. A little figuring will soon show, however, that if nothing short of high efficiency is desired, the entire power plant itself must sink into insignificance beside the imposing proportions of the preheater. An attempt will now be made to discover whether there is not on the efficiency scale some point that corresponds to a preheater within the limits of practicability.

We are confronted, first, with the necessity of finding a proper value for K. We know that a steam radiator standing in a room will give off from 2 to 3 B.t.u. per hour per square foot per degree temperature difference, when the difference in temperature between the radiator surface and the air is from 100 deg. to 140 deg. In the case of indirect heating, where the velocity of the air passing through the heater is as much as twenty feet per second, values of K as high as 11 are commonly used. In a preheater there is no obstacle to securing velocity of the gases, but there is uncertainty regarding the quantity of dust or soot that might deposit on the tubes. We can place the tubes vertically and pass the flue gas through them, with cinder hoppers underneath, and thus insure the passages against becoming clogged with dust, but beyond this we can only speculate. In the case of economizers it has been found necessary in most cases to install an automatic soot-scraping device. But in the economizer, temperature differences between the gas and the tubes are frequently as great as 500 deg., while in the preheater we would expect the difference to be little, if any, above 100 deg. The larger the heater the less is the difference. Is it possible that this low temperature difference, together with a high gas velocity through the tubes, would prevent the deposit of soot in such quantities as to seriously lower the heat transfer? We are unable to answer this without a trial. If it were so, we would expect a much higher transfer rate in a preheater than in an economizer, since in the latter the gas flows around the tubes and is thus less able to prevent the deposit of dust. The economizer is also subject to the formation of a certain amount of scale inside the tubes, and the tube itself, being usually of cast iron, is a much poorer heat conductor than the very thin steel tube which would be perfectly appropriate in the preheater.

An automatic tube cleaning device is not inconceivable in a preheater, though we are inclined to believe that the tendency would be away from complications of this character and rather toward reliance on the gas itself to keep the tube surfaces clean, with periodic scrubbing to remove the more ingrained and adhesive particles of fine soot—in short, a treatment similar to that given the tubes of a vertical, return-tubular boiler. All things considered, we should expect the value of K in a properly designed preheater to be not less than 4 and possibly as high as 10. As the imagination is left somewhat at sea when having to deal with such wide limits as this, the accompanying diagram has been prepared from the foregoing equations. This diagram clearly indicates just what may be expected of the preheater under three different conditions of heat-transfer rate.

The horizontal axis of the curves is used to express the square-foot surface of the heater as a percentage of the pounds of gas to be handled per hour. The vertical axis gives the percentage of heat recovered from the flue gases. It will be noted that each curve has a



CURVES SHOWING RELATION BETWEEN SIZE OF PREHEATER AND RECOVERY OF HEAT IN FLUE GAS (K-HEAT-TRANSFER RATE)

point of greatest curvature, and it is to be anticipated that the correct size of heater for any given conditions will lie approximately under this point. If we knew the cost of preheaters per square foot and also the true value of K, it would be a simple matter to determine the size of heater giving the greatest net return on the investment. Although we are in the dark as to these quantities, an example will nevertheless be carried through in order to fix the proportions of the subject in the reader's mind.

A certain power plant consumes an average of 50,000 lb. of coal per hour. The coal has a heating value of 13,500 B.t.u. per lb. and costs $8 per ton of 2,000 lb. Flue-gas temperatures average 500 deg. F., and it has been estimated that 20 lb. of flue gas is delivered to the stack per pound of coal, making a total of 1,000,000 lb. of flue gas per hour. Under these conditions and with an air temperature of 70 deg. and 0.25 as the specific heat of the flue gas, we find that approximately 16 per cent of the total heat in the coal is used to heat the flue gas above 70 deg. In terms of coal values this is equivalent to $280,000 a year. After a few trials, a 50 per cent recovery of this is assumed, representing a net saving in coal of $140,000 a year. From this must first be deducted the power and operat-

[1] This quantity must also take care of any mechanical or structural limitations in the heater.

ing costs of the preheater. We are reasonably certain that a heater can be designed for a frictional resistance of either air or gas of not over three inches of water. The power necessary to handle 2,000,000 lb. of gas and air per hour against three inches is about 400 hp. and would cost the power plant in the neighborhood of $70,000 a year. Add to this $15,000 for operating labor and maintenance, and the net possible saving is reduced to $55,000, out of which must be paid interest and depreciation charges on the cost of the heater installation. A total net return of 25 per cent on the investment is probably the least that would be expected, this amount to include profit, interest and depreciation. An investment to yield this return would consequently be $\frac{55,000}{0.25}$, or $220,000. Referring to the diagram on curve $K = 4$ it is found that a heater for 50 per cent recovery would contain 125,000 sq.ft. of heating surface.

It will be left to the reader's imagination as to whether a heater of this size, with its equipment of fans, air ducts, foundations, supports, insulation, etc., can be built for $220,000. It would be futile to start another array of assumptions regarding the cost of such an installation without knowledge as to its location. The cost of floor space alone would be sufficient to condemn it in certain places, while in others floor space might not be an important factor. The utmost that can be done in the way of cost generalization is to point out that such a preheater could undoubtedly be built for considerably less per square foot of heating surface than a boiler or an economizer. Whether $1.76 per square foot, according to the figures given is enough to cover it, is somewhat dubious, it must be confessed, excepting under the most favorable circumstances.

Starting with a lower recovery percentage—for example, 40 per cent—and the same basis of figuring excepting that the frictional resistance is changed in proportion to the size of the heater, it is found that $2.50 per square foot may be spent on the heater, though the project becomes less attractive on account of the lower return. A 60 per cent recovery allows only $1.17 per square foot with a net profit about the same as in the first example cited.

The results are much more encouraging when the upper curve on the diagram, or $K = 10$, is used as a starting point. For instance, 80 per cent recovery, or a saving of about 23,000 tons of coal per year, demands a heater containing 200,000 sq.ft. Increasing the frictional resistance to 4.8 in., and consequently the power and operating costs to about $125,000 per year, it is possible to spend $2 per square foot on the installation and still realize 25 per cent on the investment.

It may be objected that it is unfair to assume an increase in frictional resistance proportional to the heater size, when by dividing the gases into two streams, one may actually double the heating surface without appreciably increasing the fan duty. The effect of this procedure on the last-named example would be to increase the return on the investment from 25 to 35 per cent, leaving the unit charge of $2 per square foot the same. Objections of this nature, however, cannot be overruled without entering into questions of design, and the writers have purposely avoided this subject in the present article.

While the foregoing remarks refer to preheating only in connection with boiler practice, it is evident that the same principles of analysis apply in any industrial process that is obliged to waste heated gases.

Power-Plant Piping

By H. Blomgren

Some of the points to be observed when designing a system of piping for a power plant are as follows: The route between the boiler and engines should be as direct as existing conditions will allow. Suitable provision should be made for taking care of the expansion and contraction, so that excessive strains will be reduced as much as possible on the piping and fittings. All supply piping should be of such size as to avoid undue losses in pressure and excessive velocities, and in exhaust pipe to minimize the back pressure upon the engines.

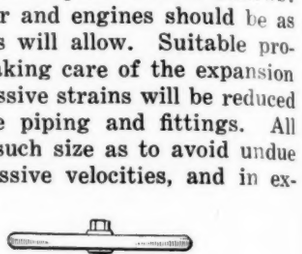


FIG. 1. VALVE WITH BYPASS

Proper joints and packing should be used to make the system steam- and water-tight, and all pipes as well as the fittings should be insulated to prevent excessive loss of heat from radiation. Special attention should be given to the matter of drainage. The condensation from separators, main headers and all low points in the system should be thoroughly removed and returned to the boilers. Although wrought-iron pipe is frequently called for in this class of work, wrought steel pipe is most frequently used, and when of good quality as to ductility and malleability, with joints properly welded, there is little advantage in using the more expensive wrought-iron pipe.

Pipe is classed according to the weight and the thickness of the shell, and is known as standard weight, extra heavy and double extra heavy. Standard-weight pipe is used for exhaust lines and for pressures up to 125 lb. Extra-heavy pipe is used for higher pressures.

Special riveted pipe is frequently used in low-pressure work of large size, such as in exhaust lines. Its advantages over other pipe are its light weight and low cost.

Pipe used to convey hot water should be of brass, as steel or wrought-iron pipe corrodes when used for this purpose. Pipe of this class includes the connections between the boilers and boiler-feed pumps, boiler accessories, etc. Seamless brass tubing is generally used for this purpose and is made in sizes corresponding with standard-weight wrought-iron pipe and is known as "iron pipe size."

Fittings used for making up wrought-iron pipe above 3 in. in diameter are of flanged cast iron, although wrought-iron or steel flanges are used a great deal in first-class high-pressure work.

Screwed fittings are generally used in making up pipe under 3 in. in diameter. In the larger pipe, however, flanged fittings are preferred as they are much easier to connect where the space is limited and easier to take down in case of repairs

Cast-iron fittings are produced in a variety of forms to meet almost any requirements that are likely to come up in the design of the piping system, and are made in two weights—standard for pressures up to 125 lb., and extra-heavy for pressures up to 250 pounds.

Gate valves are generally employed in power-plant

work where stop valves are desired. Globe valves are seldom used as stop valves because of the friction they create; they are chiefly used as throttle valves and are usually placed near the unit that they control. The gate valve, on the other hand, is unsuitable as a throttle valve, as the disk tends to chatter when partly opened, and will not regulate the supply as well as the globe valve, which can be opened full or closed more quickly.

Gate valves should always be placed, if possible, in a vertical position with the handwheel on top, and all important valves should be of the rising-spindle type, as this will enable the engineer to tell at a glance whether the valve is open or closed. Gate valves should never be placed so that the handwheel is on the bottom, as the disk, if partly opened, will form a pocket and the condensed steam in the line will tend to drip down along the spindle.

Valves 6 in. and larger should be provided with a bypass as shown by Fig. 1. This allows the steam to be admitted slowly to a pipe system when first turning on, and also equalizes the pressure on both sides of the gate, so that it can be opened easily without scoring the face of the valve and gate, by opening valves *A* and *B*. Value *C* can be used as a drip for blowing out the condensation in the line when warming up.

Joints are an important item in pipe-line design. The common type of flanged joint used for pressures up to 125 lb. is shown in Fig. 2. The pipe is threaded to full depth and the flanges are screwed in place as tight as possible. In ordering flanges of this type, it will be necessary to order them faced and drilled unless the plant is provided with the proper facilities for doing this work. Before the pipe joints are connected together, a corrugated copper gasket is placed inside the bolt circle and the joints are bolted together. This form of gasket is desirable and will last as long as the pipe. Piping made up of flanges of this kind are easily disconnected for repairs, as a section may be readily removed.

Fig. 3 shows a type of joint commonly used on high-pressure work up to 250 lb. It is known as the van stone joint, and in it the flanges are shrunk on the pipe, the ends of which are turned up as shown. No gasket is required in this case, a ground joint being used instead.

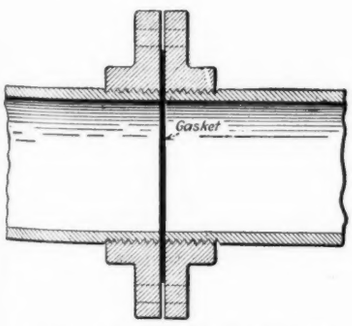


FIG. 2. COMMON TYPE OF FLANGED JOINT

In the best class of high-pressure work and where the cost is of no objection, it is customary to use wrought-iron flanges welded to the pipe. This makes the tightest and most durable joint possible. In these two types of joint it will be necessary for the designer to furnish the manufacturer with the total length of pipe desired, giving the face-to-face dimensions, as the work in connection with the flanges cannot be made on the job.

Due attention must be given to the expansion and contraction of the piping. The methods usually employed are by using sweep bends and arranging the piping so as to provide the maximum amount of flexibility, or spring; also by the use of swivel joints; by the use of expansion or slip joints. Sweep bends, however, should be used as far as possible and the piping strongly supported to allow of free movement.

Overhead piping, if not too large, is usually hung from the ceiling by means of adjustable hangers, supported from steel floor or roof beams. Pipes that run near the floor or over boiler tops are usually carried on cast-iron rollers and supported on piers. All steam and exhaust piping should be protected with some good form of sectional covering to prevent loss of heat. In case of high-pressure piping there are two reasons for this: First, to reduce the condensation and thus prevent useless waste of heat; second, to keep the boiler and engine rooms as cool as possible. All apparatus such as feed-water heaters, surface condensers, receiving tanks, etc., should be covered in a similar manner. Pipes are usually insulated with sectional covering provided with a canvas jacket and held in place by their metal bands. Valves and fittings are commonly covered with a plastic material and finished with canvas, the same as the piping. In the higher class of work molded covering is often used in place of plastic material, so that the covering may be removed for purposes of inspection or repairs and then replaced without injury.

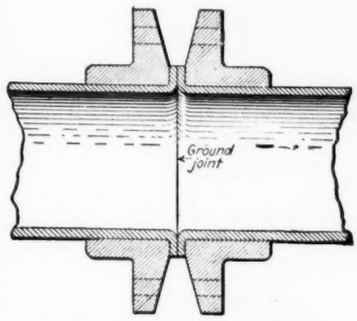


FIG. 3. JOINT FOR HIGH PRESSURES

It is probably better for an engineer to carry in his head a large number of approximate engineering constants than a small number of exact constants, but a combination is better than either alone. Hardly any engineer will deny the advantage of having tucked away in his head, for convenient reference, a few accurate constants such as the number of foot-pounds in a British thermal unit, the number of British thermal units in a horsepower-hour and in a kilowatt-hour, the weight of a cubic foot of water, and a few others of everyday use. In addition to these there are hundreds of constants that are of some practical interest. Manifestly, it would be burdensome to memorize all these. It is usually more practicable to keep in mind the "round numbers" that will meet the ordinary requirements of off-hand calculations; turning to reference books when more exact values are required. A few well-known examples of "round numbers" worth the attention of the engineer are as follows: Latent heat of one pound of steam equals oue thousand British thermal units; one pound per square inch equals two inches of mercury; one cubic foot of iron or steel weighs five hundred pounds. Such crude constants have another advantage for rough estimates in that they are particularly adapted to rapid mental arithmetic when paper and pencil are lacking.

For the prevention of water pipes bursting due to freezing, covering the pipes with a good non-conductor is recommended. It should be noted, however, that the insulating material must be kept dry as it will be useless if it becomes saturated with moisture.

Power-Plant Accounts—XII. Debit and Credit—The Cash Account

By WILFRED A. MILLER

MAKING the journal entries is the only phase of bookkeeping that calls for any power of analysis. Once the journal entries have been made in such a manner that they show the facts—namely, that the entry is to the correct classification, that it is for the correct amount, and that the amount is in the proper column, either left or right—the rest of our bookkeeping is more or less of a mechanical nature. From that point on it consists principally of the work of transcribing figures.

When the bookkeeping part of our work is completed, we are ready to make use of the information that we have been compiling. We must study it, compare results and determine whether the measures that we have instituted have worked out advantageously. Thus we see that the first recording of our information in the journal, and the interpretation of it after our bookkeeping has shuffled it into the most convenient shape, both require thought and study, whereas the actual bookkeeping part of our work is very much of a routine nature.

Although the actual work of posting, adding, transferring, and so on, is largely mechanical in its nature, it is true that for this work certain conventions have been adopted which simplify it and which, moreover, make it possible for one person to go over or to continue with another's work with little or no study of the methods employed. In order to get the benefit of these devices, we may as well discuss and make use of them. First of all we have the device with which we are already familiar; namely, the left and right columns in our journal and the left and right sides of our ledger accounts. It will be recognized that such an idea saves a good deal of time and works very strongly to prevent errors.

The beauty of the double-column method is that only additions need be made. That is, there are no subtractions. If we look over all the work that we have done so far, we will find that we have never made a subtraction in either column of any of our ledger accounts. True, we have subtracted the total of a right-hand column from that of a left-hand one or vice versa, but we have never subtracted any item in a right-hand column from any other item or items in the same column, nor any left-hand item from other entries in the left-hand column. In fact, it is one of the fundamental rules in bookkeeping never to make any subtractions in our accounts. That is why we have two columns. If we have $10,000 posted to the left-hand side of an account and for some reason wish to deduct $2,000 from it, we do not enter the $2,000 under the $10,000 and subtract it. What we do is to enter the $2,000 on the right side of the account. When we want to get the net total of the account, we subtract the one side from the other and make a note of the answer in small figures on the greater side—in this case the left one.

At this point in our work we should become acquainted with the terms usually applied to the two sides of the account. Instead of calling them the left side and the right side, we may as well substitute the technical terms Debit side and Credit side. In line with these designations we find that an entry that is made in the left-hand column in the journal or on the left side of the ledger page is called a Debit and that an entry appearing to the right is called a Credit. This somewhat simplifies the method of referring to entries. Instead of saying of a journal entry that it, for instance, is a payment by the Profit and Loss account (say to the Surplus account), we simply say that it is a Debit to the Profit and Loss account. Similarly, instead of saying of another entry that it is a sum received by the Surplus account (as a transfer from the Profit and Loss account), we say that it is a Credit to the Surplus account. Not only are the terms Debit and Credit used as nouns to indicate the entries, but they are also used as verbs to tell what to do with them. Thus we may say "Debit this amount to Repairs," which means, when fully translated, "Classify this amount as belonging to Repairs and enter it in the left-hand column of the journal." Similarly, when we say that we Credit an amount to any account, we mean that it is to be entered in the right-hand column. Instead of using the word Debit, it is frequently replaced by the word Charge. Either designation may be used. To present all these points concisely the following synopsis is given:

Left-hand entries are called Debits or Charges. When we make an entry on the left-hand side of an account, we say that we debit the account or that we charge the account.

Right-hand entries are called Credits. When we make an entry on the right-hand side of an account we say that we credit the account.

Thus, in Fig. 1, entry (a) is a debit to Profit and Loss, or it is a charge to Profit and Loss, while entry (b) is a credit to Surplus. Also, what we have done in making the entries is this: We have debited Profit and Loss, or charged Profit and Loss with $92, and we have credited Surplus with $92. These expressions will become more familiar as we use them in our future work.

It is seldom the case that both sides of a ledger account become filled up at the same time. Usually we find that either the entries on the debit side reach the bot-

This is the twelfth of a series of articles written in conversational style and treating the subject of power-plant accounts in a thorough, yet simple manner. They were prepared primarily for the guidance of the operating engineer who wishes to keep track of the cost of the power he is making, but who knows nothing at all about bookkeeping. Others may find the articles helpful in clearing up their ideas on the subject. This installment explains what is meant by the terms "debit" and "credit," and then shows the standard method of finishing one page of a ledger account and starting the next. This is followed by instructions for recording cash transactions.

tom of the page before those on the credit side, or vice versa. The question then arises what to do about continuing the account on the next page. Suppose the debit side of the Total Cost account is filled up before the credit side, as it is sure to be. The most natural thing to do would seem to be to turn to the next page and continue the debit postings on the first page. Experience has proved that it is much better to leave the unused portion of the one side blank and start both columns fresh on the new page. In order to do this systematically, we add up both sides of the page and enter the totals on the last line. This means that we never make a posting on the last line of a ledger. We always reserve it for the total of the page. An illustration of how a page is finished up is given in Fig. 2. As indicated, the posting on the next to the last line is a debit item of $40. Instead of making another posting on the page, a line is ruled at the foot of the amount column and the column is added, the total being placed on the last line of the page. In the description column we write the word "Forward" to indicate that the amount is transferred forward to some other page. In the reference column we make a note of the number of the page on which the account is continued—in this case page 61. Having done this for the debit side, we go through the same performance for the credit side. We are then ready to bring these totals forward to the new page. When continuing an account in this manner, we are always to reserve the top line of the new page for the transferred totals. That is, we are never to enter a posting on the top line of a continued page. Using the top line for the purpose thus reserved for it, gives it the appearance presented in Fig. 3. In the description column we write "Brought Forward" to indicate that the total entered in the amount column has been carried forward from another page, and in the reference column we give the number of this page, in our case page 60. The same procedure is followed for both columns. We are then ready to proceed with subsequent postings just the same as before. Making a memorandum of the ledger pages from and to which the transfers are made makes it easy to follow an account along from page to page, particularly when a number of pages have to be skipped owing to the fact that they are already occupied by some other account or accounts. When an account is continued on a new page, the number of this page should be entered in the index at the front of the ledger next to the preceding page number of that account.

(a)	Mar	31	Profit and Loss	Transferred to Surplus		92	–	
(b)		31	Surplus	Transferred from P&L				92 –

FIG. 1. EXAMPLE OF DEBIT (a) AND CREDIT (b) JOURNAL ENTRIES

60

TOTAL COST

DATE		EXPLANATION	REF.	AMOUNT		DATE		EXPLANATION	REF.	AMOUNT	
1920 Jan.	31	Fuel		1000	–	Jan.	31	Ash Removal		50	–
Apr.	30	Miscellaneous		40	–						
		Forward	61	6000	–			Forward	61	150	–

FIG. 2. STANDARD METHOD OF FINISHING A LEDGER PAGE

By adopting the suggestions here set forth, it will be found that the appearance of the accounts will be improved and that they will be in more workable shape to discover possible errors as well as far more convenient to consult for information.

Bookkeeping in the power plant differs in detail from that in use for the regular commercial activities of a business, in that actual money is not received by the power house in payment of power delivered nor, on the other hand, is money actually paid out by it for the things that it buys. That is, we who are starting to keep books for ourselves in order to find costs, have nothing to do with the handling of cash, whereas the bookkeeper for the concern is constantly making out and receiving checks. Hence, we will discover that although in our bookkeeping we may have already been handling many thousands of dollars, there is no indication in our accounts that we have spent or received any cash money. We deal in values only. However, when it is said that we handle no money it is to be understood that reference is made to the larger amounts, such as are paid for fuel and lubricants, and so on. It is quite possible that we may have a small amount of money at our disposal for making small cash purchases. Or it may be that we frequently make such payments out of our own pocket and turn in an expense slip for them in order to be paid back for our outlay. It may puzzle us as to just how such transactions fit into our records, and it is therefore well to take up the matter and come to some decision regarding it.

61

TOTAL COST

DATE		EXPLANATION	REF.	AMOUNT		DATE		EXPLANATION	REF.	AMOUNT	
		Brought Forward	60	6000	–			Brought Forward	60	150	–
1920 Apr.	30	Indirect Expenses		500	–	1920 Apr.	30	Ash Removal		40	–

FIG. 3. STANDARD METHOD OF CONTINUING ONTO A NEW LEDGER PAGE

For the purpose of the discussion we will assume that the arrangement under which we are working provides that the main office furnishes us with $100 in money for such small cash purchases as we may occasionally have to make ourselves and that this fund is periodically replenished as we use it up. What entry shall we make when we receive the money? Our first thought will, of course, be of our journals, and we can in fact record the transactions by making an entry such as shown in Fig. 4. It will be noted that the entry has been made as a debit, that is, has been placed in the left-hand column. This seems to be contrary to all our previous practice, because up to now we have followed the rule that when we paid out anything we entered it in the left-hand, or debit column, but when we received something we entered it in the right-hand or credit column. But here we go ahead and receive $100 in cash and then,

instead of making it a right-hand entry as we do in the case of payments received for ashes, we deliberately go to work and make it a left-hand entry. Why?

This point needs a little explaining. When we make a journal entry for a payment for repairs, we say to ourselves, "We are paying $75 for firebrick to repair our furnaces, therefore we must enter the $75 in the left-hand amount column; that is, in the debit column."

	Mar.	10	Cash	Cash for Petty Expenses	100	–		

FIG. 4. JOURNAL ENTRY FOR CASH RECEIVED FOR EXPENSES

	Mar.	10	Repairs	Parts for Unit No. 3	100	–		

FIG. 5. ANOTHER WAY THE ENTRY IN FIG. 4 COULD BE HANDLED

	Mar	15	Repairs	Stoker parts	40	–		
		15	Cash	Repairs			40	–
		16	Repairs	Sundry Items	60	–		
		16	Cash	Repairs			60	–

FIG. 6. DOUBLE ENTRIES IN THE JOURNAL

Now, as a matter of fact, we are not paying $75 at the time we make the entry. We ourselves will not make the payment at all, and the person who actually does the paying—the proprietor—may not attend to it for weeks to come. In the same way, when we make a journal entry for $50 received for ashes, we do not mean to say that we have actually received $50. The contractor will probably not pay the amount until the end of the month, and then he will not give the money to us, but will probably send a check for it to the owner. What we really mean when we make the first entry is that we have incurred an expense for which we will have to pay some time in some manner, whether directly in cash or otherwise. Likewise the second entry really records the fact that we have put someone else under obligation to ourselves. Now, when we receive cash from the proprietor, we have incurred an expense because the money is not owing to us for anything. Let us put it this way: We report to the proprietor that we need a number of repair parts costing $100 for unit No. 3. Upon being so notified, he immediately orders the parts and in due course we receive them. Thereupon we very properly make a journal entry debiting $100 to Repairs. Suppose now, however, that instead of ordering the parts for us, the proprietor had told us that he was too busy to attend to the matter and, to get rid of it, had given us $100 in cash and told us to go out and buy the parts. Let us further suppose that we had immediately gone out and bought them, assuming for the sake of argument, that we could pick them up out of stock. In that case we would have spent the $100 right away and have come back with the parts. When we returned, we would have made a journal entry exactly like the one that we would have made if the parts had been ordered for us and received by express. Just because the proprietor sent us after them, instead of taking care of the matter himself, would make no difference in the situation. What happened was that we took $100 in money and transformed it into $100 of repair parts. If we had lost the $100 in cash on our way to buy the parts, we would have incurred just that much expense.

Looking at it in this light we see that what actually takes place when the cashier turns over $100 to us for our petty expenses might be put this way: We say to the proprietor, in effect, "We expect to have $100 cash expense for repair parts for unit No. 3 this month. If you will give us the money now, we will take care of the purchases ourselves." We could then make a journal entry like the one in Fig. 5 instead of that in Fig. 4, because we would know beforehand what we were going to spend the money for. Then, when we did actually spend it and get the parts, we would have to make no further entry in our journal because we already had recorded the expense.

When, however, we do not know exactly what we are going to spend the money for, we cannot very well follow that course. We must simply record the fact that we have the money to hold until we spend it. So, what we actually must do, is to say to ourselves, "Here we have $100 that does not belong to us; we owe it to the proprietor the same as we would owe the boilermaker if he made some repairs for us. So we will charge the $100 as an expense, and since we have no account to charge cash to, will open a new ledger account and call it Cash. Then, when we actually spend the cash and convert it into repairs or other things, we will be changing it from one kind of expense into another; that is, from cash into repairs or whatever it may be." The result of such a conversion would be that we would no longer be owing the cash to any one and that the item of expense should be wiped off the books. We can readily do this by making a double entry whenever we spend any of the cash entrusted to us. Fig. 6 illustrates such double entries. When we spend $40 for repairs on March 15 we reduce

CASH

DATE		EXPLANATION	REF.	AMOUNT		DATE		EXPLANATION	REF	AMOUNT	
Mar.	10	Cash for petty expenses		100	–						

FIG. 7. ENTRY OF FIG. 4 POSTED TO CASH ACCOUNT

REPAIRS

DATE		EXPLANATION	REF.	AMOUNT		DATE		EXPLANATION	REF.	AMOUNT	
Mar.	15	Stoker parts		40	–						
	16	Sundries		60	–						
				100	–						

FIG. 8. REPAIRS ACCOUNT ON MARCH 16

our cash obligation by that much. Similarly when we spend $60 for sundry repairs items on March 16, we reduce our cash obligations by that much more.

It will be interesting to see how these entries affect our ledger accounts, so we will follow them through. On March 10 we became indebted for $100 cash as indicated by the entry shown in Fig. 4. Posting this entry would make the Cash account look like Fig. 7. After

making the entries of March 15 and 16, we would post them. That would make the Repairs account look like Fig. 8 and the Cash account like Fig. 9. An examination of the two accounts will show that the two sides of the Cash account both show $100, so that the cash on hand is zero, whereas the Repairs account totals up to $100 on the left side, that is, the debit side. The facts are, that on March 10 we showed an expense of $100 in

CASH

DATE	EXPLANATION	REF.	AMOUNT	DATE	EXPLANATION	REF.	AMOUNT
Mar. 10	Cash for petty expenses		100 —	Mar. 15	Repairs		40 —
				16	Repairs		60 —
							100 —

FIG. 9. CASH ACCOUNT ON MARCH 16

the cash account, while on March 16 we showed no cash expense, but showed a repair expense of $100. That is, we have converted a $100 expense into a $100 repairs expense.

We now see why we must make a debit entry of cash which we receive instead of a credit entry. However, the fact that we had to make any explanation at all, shows that we ought to have some surer method of deciding whether a transaction is a debit or a credit than the rule that we originally started out with; namely, that anything we spend is entered in the left-hand column and anything that we receive in the right-hand column. A more general rule is that debits are those items for which the concern must pay in cash, whereas credits are those for which the concern receives cash. this covers the case of cash itself, because when the concern pays cash to us it is just like paying cash to anybody else, and the transaction is therefore to be considered as a debit. While this rule is more general than the one used thus far, it in turn is not foolproof, but it will serve our purpose very well until such time as we have progressed far enough to evolve a more comprehensive one.

While it would be perfectly correct and proper to handle transactions in cash through the medium of journal entries as indicated in Figs. 4 and 6, it will be found more convenient to use a separate book for the purpose. It is always desirable to know just where we stand so far as our cash is concerned. If we were to handle it through journal entries and postings to the ledger account for Cash, we would always have to be right up to the minute with our postings if we wanted to be sure of just what our cash balance would be. In order to avoid the necessity of doing this and to secure other advantages that experience has proved to be inherent in the scheme, it has become the usual practice to keep the cash entries entirely separate from any others, in a book of their own. That is, a separate journal is kept for cash, and it is distinguished from the general journal by calling it the cash journal. This is its true name, but it is also very generally spoken of as a cash book instead of a cash journal. The cash journal differs somewhat from the general journal. Instead of having two columns for amounts on one page, it has only one, but instead of making both debit and credit entries on the same page, the left-hand page is reserved for debit entries only and the right-hand one for credit entries only. That is, each page of the cash journal is really two pages, and in order to carry out this scheme it is necessary that the book be started on the second and third pages. It is obvious that to carry out the scheme the third page must go with the second, the fifth with the fourth, and so on. Reference to Fig. 10 will show how the cash book would look if we were to use it for recording the cash transactions indicated in Figs. 4 and 6 instead of using the general journal to do so.

We can use a blankbook for the purpose, such as we are already using for our general journal and our ledger. It will be necessary to rule only a few pages as it is not likely that we will have many entries to make in it. Referring to the illustration, it will be seen that the two pages of the cash book combined have very much the appearance of a ledger account with its left and right sides somewhat wider than the ordinary ledger account. As in a ledger account the left side is used for debit entries and the right side for credit entries. This peculiarity of the cash book makes it possible to dispense with the postings of its entries to the ledger. That is, we don't have to open a ledger account for Cash at all. We can use our cash journal for the purpose, because it not only gives us the detail of each transaction, but, being confined to cash transactions only contains the information in exactly the same way in which it would appear if posted to a ledger account. That this is so can readily be verified by comparing Fig. 10 with Fig. 9. Except for the fact that in Fig. 10 the account is spread over two pages, it is an exact copy of the ledger account illustrated in Fig. 9. It is therefore evident that it would be a mere waste of time and energy to post the cash-book entries to a ledger account, since this would merely result in duplication.

DATE	EXPLANATION	AMOUNT	DATE	EXPLANATION	AMOUNT
Mar. 10	Cash for petty expenses	100 —	Mar. 15	Repairs	40 —
			16	Repairs	60 —
					100 —

FIG. 10. CASH BOOK ENTRIES REPLACING THOSE OF FIG. 4 AND FIG. 6

Of course it is to be understood that the cash book will seldom show both sides adding up to the same amount. Ordinarily, there is always some cash on hand, which means that the debit side is greater than the credit side. In fact, when the difference between the two grows small, the cash on hand is replenished by the

cashier, which entails a debit entry, thus again increasing the margin between the two sides.

The foregoing is the best method of handling cash when we are allowed a fund with which to work. It may also be used in cases where we spend our own money for small purchases and then get it back from the cashier by making out an expense slip. In that case we would

	Apr	6	Miscellaneous	Gaskets	4 35	

FIG. 11. A JOURNAL ENTRY FOR CASH ADVANCED BY THE ENGINEER

find entries on the credit side of the cash book before we had an entry on the debit side, which would of course mean that the concern owed us money instead of our owing the firm any. While this method could be followed, it would involve introducing our own personal cash into the books of the concern, which is objectionable. It would, on the whole, be preferable for us not to keep any cash book at all in that case. When we made a purchase out of our own pocket, we would simply make an entry for it as if it had been received on an order. For instance, if we had bought some gaskets for $4.35, we would make an entry in our journal like the one in Fig. 11, without any regard to the fact that we paid for it personally. Of that fact we would make a personal memorandum, and later in the week or month we would submit an expense slip for it or include it among other items on such a slip. We would then get our money back from the cashier, but so far as our bookkeeping is concerned, there would be no hint of that phase of the transaction. Being a personal matter between the conpany and ourselves there is no reason why the cost books should know anything about it.

Westco Rotating Pump

But one moving part is the distinctive feature of the Westco rotating pump. This is a bronze or alloy impeller that is secured to a monel-metal shaft and has a certain determined number of blades on each side of the outer rim, Fig. 1. The impeller, rotating at high velocity in the water channel, causes the water to be

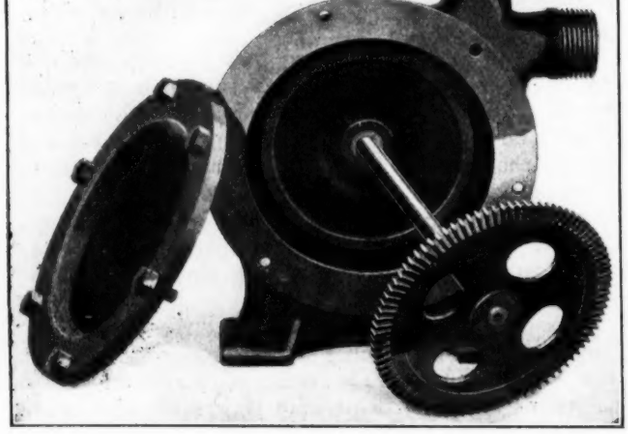


FIG. 1.—PUMP WITH COVER AND ROTO REMOVED

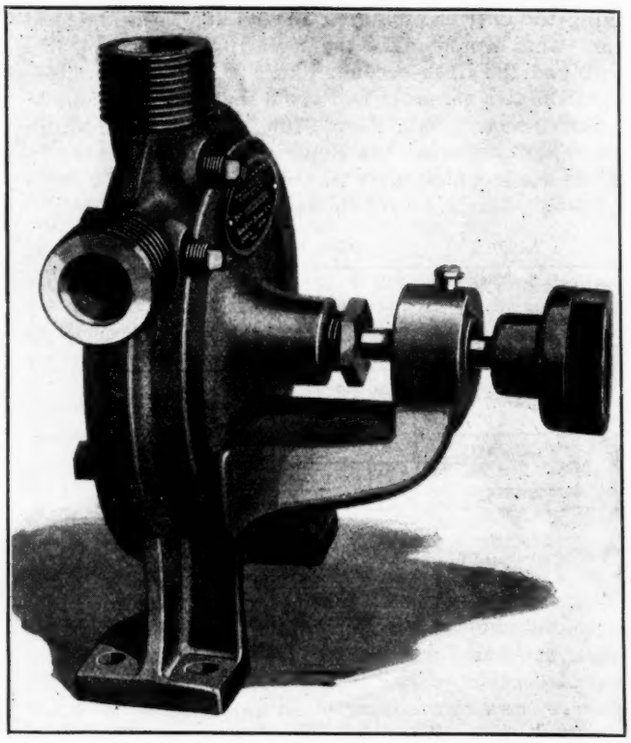


FIG. 2. PUMP ASSEMBLED SHOWING INLET AND OUTLET CONNECTIONS

drawn from the source of supply and discharged under pressure at the outlet. The water is taken in at the periphery and is discharged at the periphery (see Fig. 2).

While the construction of the pump is simple, the diameter, thickness and speed of the impeller as well as the number, depth and length of blades, also diameter, area and shape of channel, are accurately determined, and the operation of the pump as a whole is dependent on each one of these factors and its relation to the others.

Most of these pumps are directly connected to an electric motor. The shaft revolves in two ball-thrust radial bearings, run on hardwood sleeves to prevent wear on the shaft, and protect the pump from the motor thrust, not taken up in the flexible coupling. These bearings are packed with grease at the time of shipment and need refilling only occasionally. Most of these pumps are made for standard 1,800-r.p.m. electric motors, which generally operate under a full-load speed of 1,750 r.p.m.

The pump, which is also built for belt connections to gas engines, electric motors or lineshafts, is manufactured by the Western Pump Co., Davenport, Iowa, and the Plant Engineering and Equipment Co., Inc., 192 Broadway, are the distributing agents in the New York territory.

In considering the installation of an economizer, it should be borne in mind that the economizer is more than a mere economic unit like a feed-water heater. The economizer should be considered as the first step in raising steam from water as received by the boiler plant, and as such is part of the steam-generating plant; consequently, if less economizer heating surface is installed, it is logical to allow that more boiler-heating surface will be required.

EDITORIALS

The Mechanicsville Boiler Explosion

NOTWITHSTANDING our conviction, and our habit of expressing it, that boiler explosions are as a rule preventable by human foresight and inspection, there occasionally occurs an explosion which baffles all attempts to account for it or to discover the causes that brought it about.

Such an instance is that which occurred at Mechanicsville, New York, in August, the particulars of which have just become available and are to be found on pages 833 and 834 of this issue.

The explosion has this in common with many others, that it occurred at a time of interrupted operation—that is, after the boilers had been out of service and were ready to cut back into the line. Many of its features are indicative of overpressure, and the fact that its stop valve had not yet been opened, allowing no outlet for steam that might be formed, although heat had been applied to the boiler, would be conducive to this were the safety valve inoperative. The safety valve, however, when tested, after having been thrown six hundred feet and through a concrete roof, began to leak at a low pressure and blew freely below the pressure that the boilers were allowed to carry. How lately it had been tried, or what were the habits of the operatives with regard to testing the safety valves, we do not know.

A defect in the safety-valve nozzle has led to a suggested application of the Lawson theory; that is, that a rupture of this fitting released the pressure upon the contents of the boiler so suddenly that their expansion through the formation of steam at the lower pressure in the body of superheated water was enough to produce a water-hammer effect sufficient to produce the explosion.

Utilizing Anthracite-Mine Waste Efficiently

UTILIZING, for power purposes, low-grade coals and the waste incident to mining the better grades, has been attracting attention for many years, but it remained for the coal shortage during the war and the year following to bring about serious effort in this direction. Even some of the poorer grades of coal increased two and three times in cost, besides being difficult to obtain. This resulted in extensive efforts being made to devise ways and means of alleviating this burden. In the eastern part of this country, whenever utilization of waste coal at the mines is considered, attention is focused on the culm banks that have accumulated at the anthracite mines and the deposits that have washed down into the rivers and streams from the operations in these regions.

Anthracite culm, although comparatively high in heat value, has a high ash content running, in many cases, over twenty per cent, and is low in volatile matter, frequently below five per cent. One of the latest attempts to utilize this culm—that made by the Philadelphia Rapid Transit Co. in its Mt. Vernon Street Station, to burn this material in pulverized form—is described in the leading article in this issue. Successfully burning bituminous coal in pulverized form is not only an accomplished fact, as attested by a number of installations, but also it has shown certain advantages over other methods of firing. There are many features that tend to make the burning of pulverized anthracite a more difficult problem than that of pulverized bituminous. The hard and abrasive qualities of anthracite cause the maintenance of the milling equipment to be high and reduce the output to about fifty per cent of that for soft coal. The low volatile and the high ash content is a serious obstacle in the successful burning of the coal after it has been pulverized. Furthermore, in applying pulverized-coal equipment to an old hand-fired boiler installation like that of the Philadelphia company's, the design generally has to be a compromise to meet the available space for furnace and burners. Notwithstanding these difficulties, the test results given in the article indicate that it is possible to burn these low-grade fuels at comparatively high efficiencies. Although there may be much to be desired in the way of improvements in this installation, it is nevertheless a piece of pioneer work of considerable consequence, in the direction of more efficiently utilizing our fuel resources. The present greatly reduced cost of high-grade coals will undoubtedly retard interest in utilizing the lower grades, especialy when the latter has to be transported considerable distances, but burning these grades at the mines still offers a fruitful field for development.

The Air Economizer

IT IS generally accepted that there is more room for improvement in the economy of boilers than in that of engines or turbines. This is in spite of the fact that the best boilers utilize about four-fifths of the heat in the coal, while the best turbo-generators turn less than one-quarter of the heat in the steam into electrical energy. The important consideration is that most of the heat discharged into the condenser is absolutely beyond recovery, while much of that going up the stack in the hot gases can be recovered. The only question is whether the gross saving will be worth the cost of obtaining it.

The water-heating economizer ordinarily works under the disadvantage that the water coming to it has already been heated to a certain extent by exhaust steam. In such a case the economizer heating surface, representing a large investment, has little to do, and it is also theoretically impossible for it to take all the heat out of the flue gases. If cold water were fed to the economizer, these two objections would cease to exist, but this procedure would ordinarily mean that some of the available exhaust steam would be wasted and there would be the added objection of sweating.

It has been proposed that air preheaters be used instead of the ordinary type of economizer. Such an

arrangement might use metal tubes with the hot flue gases and the furnace air supply moving on opposite sides of the tube walls. This apparatus would, of course, be operated on the counterflow principle so that the hot flue gases would first pass the hottest part of the air stream and move on toward the cold-air inlet. Theoretically, such an apparatus could be constructed to transfer all the heat from the flue gases to the inlet air, cooling the former to room temperature and heating the latter to a temperature a little higher than that of the original flue gas. Practically, this one hundred per cent recovery could not be obtained, but it is reasonable to suppose that from eighty to ninety per cent might be recovered if a sufficiently extensive heater were used. The commercial success of an air preheater designed for such a large recovery seems very doubtful. As in many other things, it is the last little gain that costs the most money. By being contented with a lower percentage of heat recovery, it would be possible to get a much larger saving per dollar invested. Therefore the practical application, if any, of this apparatus will doubtless be found in the lower ranges of heat recovery.

In this issue of *Power* is an article entitled "Utilizing Flue Gases to Preheat Air to Furnace." The authors, E. R. Welles and C. T. Mitchell, frankly admit the great uncertainty that exists in regard to the principal factors involved. By making what appear to be reasonable assumptions, they get results that seem to bring the air preheater into the field of commercial possibilities.

Why Wait for an Emergency?

THE politician typically deals in expediencies. In no recent events has this truism been more clearly demonstrated than in the spasmodic attention and inattention given to national coal legislation. When coal is high or the supply is inadequate, Federal legislators rush about shouting loudly in the defense of the public. They promise legislation "with teeth in it." They orate, they introduce bills, they make speeches, they hold hearings. And then? Nothing!

At present there is a state of inaction as to these matters. The Frelinghuysen bills, the Calder bills, the Newton bill and all the other legislation grandly conceived and widely advertised gathers dust in the legislative pigeonholes.

It seems almost useless to urge action upon national coal legislation just now. There is not that urgent appeal of necessity which characterized this season a year ago. Business has been for many months running at subnormal rates, and the demand has been met with ease. However, one can well anticipate other periods of stringency in the future. It is too much to expect that there shall be no more transportation labor troubles; that storms never again will tie up our rail systems for a week at a stretch; that the coal miners will always settle their wage difficulties with the operators without interruption of coal production. Until the millennium arrives, we can certainly anticipate from time to time short interruptions of full coal supplies, and in these periods of interruption there are likely to be instances of serious shortage with the corresponding temptation to injustice on the part of the coal trade by the exceptional opportunity of high prices.

In the comfortable situation of today as to fuel supplies, it should be easy to draft legislation establishing basic principles which can be recognized as sound and fair to cover these abnormal cases. It certainly would be far better to do it now than to wait until the emergency arises. In the emergency it is likely that the legislation might go too far; and in any event it would be hastily conceived and probably faulty in detail. Why, then, would it not be better for all concerned, including coal producers and coal wholesalers first of all, to have some action taken now?

The Ammonia Heat Chart

THE question of economical temperatures in the refrigerating plant is an important but imperfectly understood one. Because of the lack of definite information on the subject, it is not at all unusual to find a plant operating at a low efficiency as a result of improper temperature conditions. This is not surprising, since it is rather difficult to show the economy secured by high suction pressures and low head pressures without an insight into the theory of refrigeration.

On another page appears a discussion of these factors, together with an ammonia heat diagram. If the engineer will read this discussion and make use of the diagram shown, not only will he arrive at an appreciation of temperature control, but he will be able to solve many problems that so far have been guessed at owing to the necessity of using a considerable amount of mathematical computation.

The use of the heat chart is extremely easy, even though its construction involves a large amount of mathematics. Like all similar graphical charts it is exceedingly simple. As shown in the article, many problems such as the refrigeration duty secured, horsepower per ton of refrigeration, losses due to low suction pressure and high discharge pressures, conditions of the ammonia coming to the compressor, et cetera, are easily determined.

No man knows his business so well that he can afford to close his ears to the suggestions of his subordinates. It may be that many of the suggestions received cannot be put into effect for some good reason. These, however, should not be turned down too sharply if they are made in good faith. Care should be taken to explain where possible why these suggestions cannot be adopted, and to express appreciation for the interest shown. Failure to do so may not only lead to the shutting off of a supply of ideas, some of which would surely be of value, but may also kill the spirit of teamwork. Without teamwork things will always be going wrong and even the best laid plans of the boss will somehow fail to work as well as they should.

O. C. Merrill, executive secretary of the Federal Power Commission, recently called attention to the great difficulties under which that body is working in its effort to handle the many water-power applications that are being received. He points out that the commission lacks the money to carry out the provisions of the Water Power Act as originally intended. He says that the worst feature of this condition is that the commission cannot take up the valuation of projects that are already constructed. This is a good example of the Government's unfortunate practice of passing laws and then failing to provide enough money to carry them out.

PRACTICAL IDEAS from PRACTICAL MEN

The Load on an Engine

The total load on an engine is naturally divided into three parts. Fig. 1 is assumed to be a diagram from one end of an engine, and the diagram from the other end is just like it. The horsepower constant is 10. *A* is the atmospheric line and *V* the vacuum line. The average pressure of the space *B* is 60 lb., therefore it requires $10 \times 60 = 600$ hp. to drive the machinery. The average pressure in *C* is 5 lb., therefore it takes $10 \times 5 = 50$ hp. to force exhaust steam out of the engine and through the heating system. The average

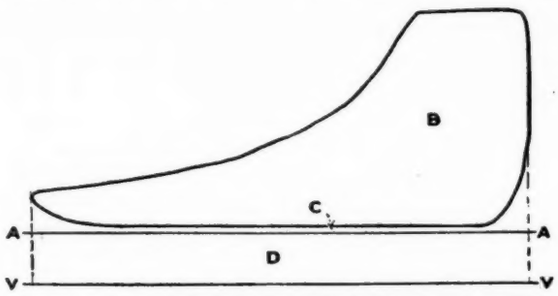


FIG. 1. DIAGRAM OF ENGINE OPERATING WITH HEATING SYSTEM

pressure in *D* is 15 lb., therefore the engine uses $10 \times 15 = 150$ hp. to force exhaust steam out against the atmospheric pressure. The total load on this engine is $600 + 50 + 150 = 800$ horsepower.

During the summer the exhaust steam is allowed to escape freely to the atmosphere, therefore the diagram, Fig. 2, shows the internal conditions. As the space *C*, Fig. 1 has been eliminated, the total load is now $600 + 150 = 750$ horsepower.

A condenser is added and the diagram Fig. 3 results. The average pressure in *D* is now 3 lb., hence the power used to overcome atmospheric pressure is $10 \times 3 = 30$ hp. and the total load is $600 + 30 = 630$ horsepower.

As less coal is required for 630 hp. than for 800 hp., it gives a proper reason for the smaller amount of coal burned to operate a condensing engine. To claim that the addition of condenser increases the power of an engine is certainly a mistake.

An engine builder is asked to quote price and guarantee results for an engine to develop 600 hp. to drive machinery in a factory. The exhaust steam is to be used in a heating system under 5 lb. pressure, and a condenser is not to be included. Free escape of the exhaust steam is to be given due consideration.

Price and results are also requested for the same engine when running condensing under 26 in. vacuum. The price is not considered here. The engine builder knows that his engine will develop a horsepower-hour for each three pounds of coal burned, provided the total

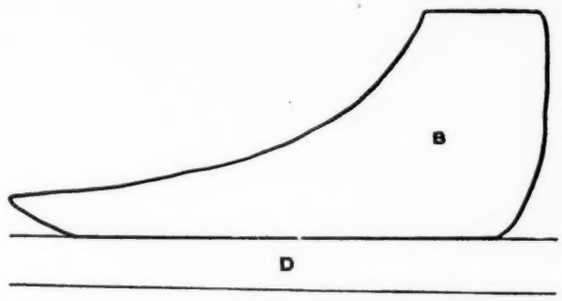


FIG. 2. DIAGRAM OF ENGINE EXHAUSTING TO ATMOSPHERE

load is taken into consideration. As this is 800 hp., the coal required will be $800 \times 3 = 2{,}400$ lb. per hour. He is also aware that the steam user will base results on the power actually required to run his machinery. His guarantee is therefore $2{,}400 \div 600 = 4$ lb. of coal per horsepower-hour. When a free exhaust is provided,

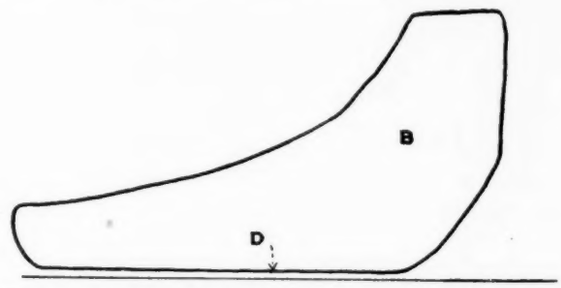


FIG. 3. DIAGRAM OF ENGINE RUNNING CONDENSING

this can be reduced to $750 \times 3 \div 600 = 3.75$ lb. of coal per horsepower-hour.

When this engine is operated condensing, the rate will be reduced to $630 \times 3 \div 600 = 3.15$ lb. of coal per horsepower-hour. Not all of the fine points involved are mentioned here.

In the issue of Sept. 20 R. A. Livingston makes re-

marks concerning tables of pressures. The main fault with this philosophy is that he has neglected to take into account the fact that badly informed engineers persist in using these tables as if they were mean effective pressures when they are not.

New Haven, Conn. W. H. WAKEMAN.

Truing Large Flywheels While in Place

The illustrations show an extemporized rig for grinding the faces of a pair of gas-engine flywheels that were too large to be placed in any lathe available. The same method, with various modifications, refinements and improvements, could be used for machining large pulleys and other apparatus found about a shop or power plant where the equipment is limited or when the work must be quickly done. An improvement would be a self-contained motor grinder, preferably with the wheel mounted directly on the motor shaft.

As shown by Fig. 1, the engine is bolted to the shop floor near the lineshaft and one of the flywheels is driven at slow speed from a small-diameter pulley on the shaft. The shaft itself might be wrapped with friction tape and the belt run directly upon it. An ordinary grinding-wheel stand, Fig. 2, the bearings of which must be in good shape, is mounted on a sliding base made up of hardwood boards, steel angle plates and steel rods sliding through holes drilled in one set of angles and made fast in the other set. A threaded feed rod is tapped into the center of the angle plate bolted to

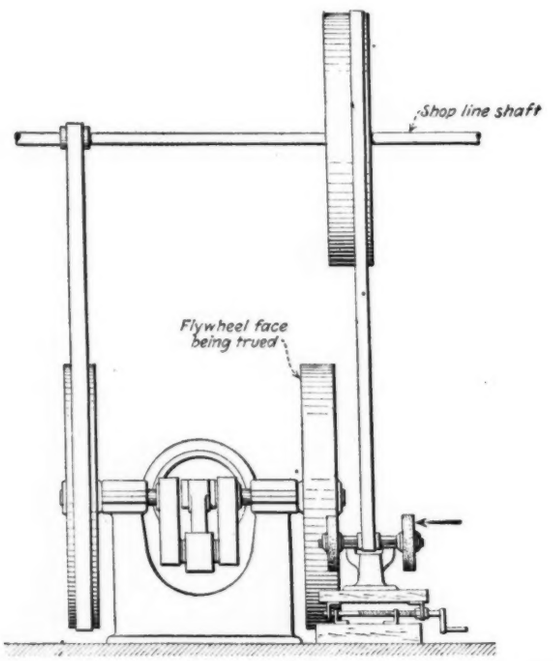


FIG. 1. ARRANGEMENT OF ENGINE AND GRINDER DRIVE

the lower baseboard and carries the upper base with it as it is screwed in and out by means of the crank handle; the wheel is fed across the face of the work by this means.

As the wheel needs to be fed into the work but a small amount, this was accomplished by driving a wedge under the outside edge of the grinder-stand base, after loosening the bolts a little.

If the wheel face to be trued is to be straight, it is only necessary to bolt the sliding base to the floor so that it slides parallel to the wheel face, best determined by trial cuts. If a crowned face is required, this can be put on by grinding two straight tapers, half the width of the face, by providing holes in the lower baseboard larger than the bolts, so that the grinding-wheel stand may be shifted slightly about a vertical axis to obtain the proper angle of the crown.

The grinder is either driven by a belt over a large

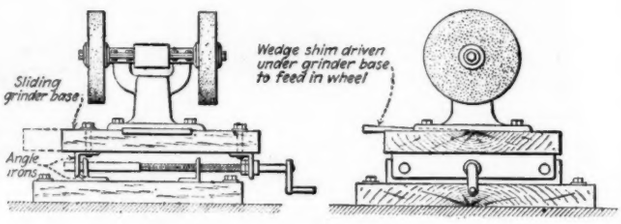


FIG. 2. DETAILS OF GRINDER AND FEED METHOD

pulley on the lineshaft, the pulley face being wide enough to allow the belt to move along as the grinder is fed across the wheel face, or an electric motor drive may be rigged up. If both engine flywheels have to be trued, after finishing one the drive belt and pulley can be changed over to it and the grinding-wheel stand bolted in front of the second wheel and the process repeated.

H. H PORTER.

Oakland, Cal.

Open Circuit in Transformer Caused Unbalanced Voltage

In a generating station used as a relay for a hydroelectric system having transformers connected as in the figure, the operator noted one night, while the plant was not running, that the lights were exceptionally bright. Consulting the voltmeter, a reading of 124 volts was found in place of the normal 110. The operator called up the dispatcher, reported the high voltage and was told that the voltage on the system was normal.

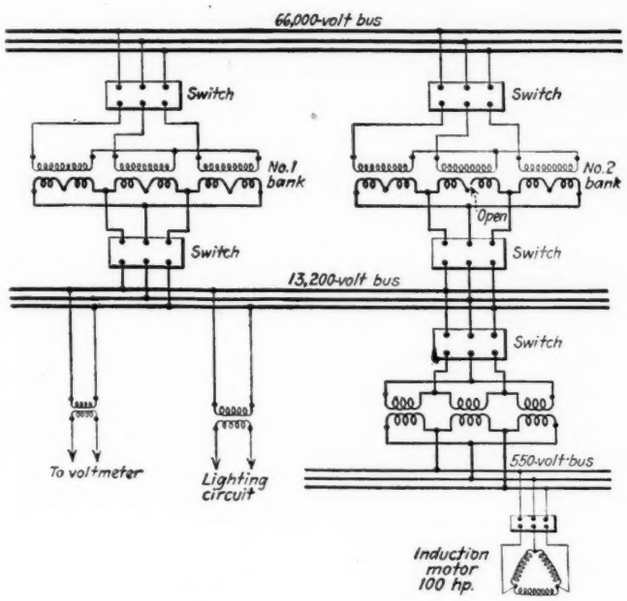
At this time No. 2 bank of transformers was in operation. A change was made to No. 1 bank, and the voltage dropped to normal as soon as the No. 1 bank switch was closed and remained normal after the opening of the No. 2 bank switch. The operator then changed back to the No. 2 bank and found the voltage high, as before. He then started a 100-hp. three-phase induction motor, and the voltage dropped to normal. As soon as the motor was shut down, the voltage again went back to the 124 volts.

After looking the transformers over, he noticed that when the induction motor was running, connected to No. 2 bank, there was a bubbling sound in one of the transformers. No. 1 bank was then put on and the high-tension switch on No. 2 bank left open, with the low-tension switch closed. By touching the high-tension terminals of No. 2 bank with a switch pole, it was found that the lead from the middle transformer was dead. It was also noticed that there was no hum or vibration in this transformer case.

This test indicated an open circuit in the low-voltage windings of the middle transformer of the No. 2 bank. The transformer's cover was removed and it was found that the connecting bar between the two sections on the low-tension side had not been properly tightened.

Owing to the poor contact the arc formed, had burned away the copper, gradually increasing the size of the hole in the bar until it formed an open circuit.

It is difficult to state why the three-phase motor was able to start under these conditions, although it seems as though the starting of this motor must give a greater drop in potential across this open circuit, which would



allow the breakdown of the oil film and cause the bubbling sound mentioned. It is also difficult to account for the increase of about 11 per cent voltage. The repairs consisted of putting in a new bar and new stud, as the threads on the stud were burned too badly to use for the connection.

L. A. FITTS.

Montague City, Mass.

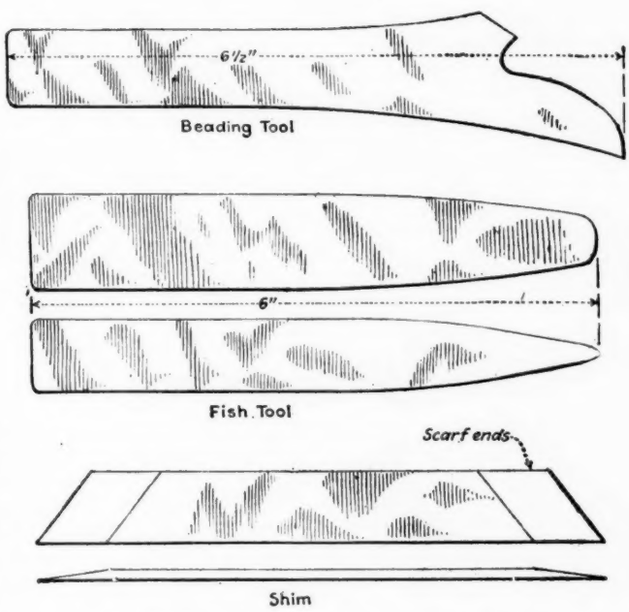
Renewing a Boiler Tube

Most anyone can renew a boiler tube after once being told how. First, a piece of pipe longer than the tube is shoved through it. Then a circle is chalked around both ends of the tube to make sure that work is performed on both ends of the same tube, instead of one end of two different tubes. Then the bead is cut off at the rear end with a cold chisel, and the tube is split lengthwise by grooving from the end back just inside the tube sheet, taking care not to cut the sheet. After grooving, the tube is collapsed by driving a fish tool (see illustration) between the tube and the sheet. The front end of the tube is freed the same as the rear, except that a cape chisel is driven through the tube back of the sheet. This tool splits the tube and collapses it, and by hammering on the top end of the cape chisel the wall of the tube is forced inward and upward. Meanwhile the sheet is protected from injury by the tube. After using the chisel the tube is grooved and collapsed the same as at the rear end.

After collapsing both ends, a short piece of pipe is inserted in the rear end of the tube, and the tube is then driven forward through the front head. When the tube projects through the head about a foot, a hole is made in it and a tackle is hitched on to pull it out. The last six feet is usually the worst, and considerable hammering on the tube may be necessary to loosen the scale. Always take care to pull the tube straight and to hammer it enough to loosen all the scale. Thoughtless workmen sometimes give the end of the tube an oscillating motion to loosen the scale, but it should not be done as it injures the tube sheet. The tube sheet is soft and easily scoured by scale, and if cut too deep it is hard to make the new tube tight. It may take a little longer, but it is worth the time to be careful when removing the tube and avoid trouble later on.

After the old tube is removed, the holes in the sheets should be inspected for injuries before the new one is put into place. Sometimes the tube hole becomes so badly scoured that it is necessary to ream it. If a standard tube is expanded in the new hole, it would be too thin and might soon leak or break off at the sheet. To prevent this, a shim is made of soft sheet iron and put in around the tube, but this shim is not long enough to go all around the tube. After the shim is put in, the tube is rolled the same as any. Tin should not be used, as the chemical action of the water will eat it and soon cause the tube to leak and, if then rolled, will cause trouble for the engineer.

When the new tube is in place, it should not project less than one-fourth nor more than one-half an inch



RETUBING TOOLS AND TUBE SHIMS

beyond the tube sheet. If too long, the expander cannot do its work properly, and if too short there is not enough left to bead—three-eighths of an inch is best. If it is necessary to saw off the end of a tube, be careful to have the end square.

After the new tube is in place, each end is flared with one good hard blow from a 1-lb. ball-peen hammer. This is to prevent the tube from crawling in the opposite direction while work is being performed on an end. After flaring, the rear end is rolled, first putting a little oil on the rolls to prevent them from scouring the tube. Then the end is roughly beaded over with a hammer and finished with a beading tool. The tube is rolled again after beading, as it might have become

loosened from the hammering. Do not roll the tube too hard, as this makes it thin and it will soon leak. When the hammer bounces from the pin in the expander, it is rolled enough. The front end is rolled the same as the rear.

To test for leaks, fill the boiler with cold water to the top of the gage glass, and if it does not leak then it will not, because, when under steam, the tube is slightly hotter than the sheet and the expansion will keep it tight.

BURTON W. WHEELER.

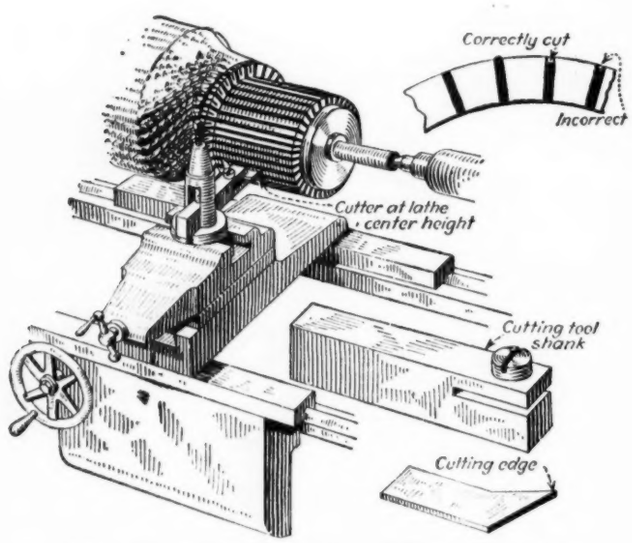
Rockland, Mass.

Undercutting Commutator in Lathe

In overhauling small motors and generators, after truing up the commutator surface it is customary to undercut the mica insulation between the segments to a uniform depth, depending on the size of the commutator. One method is to groove out the insulation by hand with an old hacksaw blade. This is slow and uncertain, and unless performed by a skilled worker, the undercutting will be uneven and there is danger of the tool slipping and cutting the soft copper commutator segments.

A better way is to mount the armature in a lathe, the commutator pointing toward the tailstock, and then shape out the grooves with a special tool held in the toolpost holder, the carriage being reciprocated by hand and the tool fed in by means of the cross-feed. The toolholder is made of a piece of rectangular cold-rolled steel stock; one end is slotted with a hacksaw, horizontally, and drilled and tapped for a setscrew to clamp the cutter in place.

A piece of heavy hacksaw blade, ground to shape and with the temper slightly drawn, is used for the cutter,



RIG FOR UNDERCUTTING COMMUTATOR MICA

being given the outline of a shaper tool or keyway cutter, but modified as operating conditions require. It is set with the cutter point toward the armature, and the tool is fed along until it brings up against the connection lug end of the commutator. The holder must be blocked up in the toolpost until the cutter is exactly at lathe center height. No index rig will be needed, the segments being placed by eye and the shaft then clamped by screwing in the tailstock center.

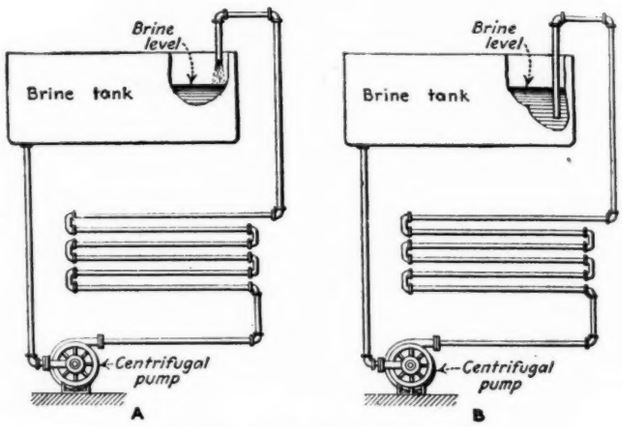
The slots must be cut cleanly, with square corners, the cutter point being ground to the width of the slots so that the whole width can be cut at once and given a straight cutting edge. V-shaped slots, round corners, semicircular or slots of varying depth are considered incorrect. If the tool can be so ground and set that the whole depth can be made in one cut, the time of the operation will be shortened.

P. H. HARRIS.

Oakland, Cal.

Corrosion in Brine Piping

For a number of years a considerable number of the brine coils in a refrigerating plant under my charge were renewed each year because of the excessive cor-



BRINE TANK CONNECTIONS

rosion of the iron piping. The matter was investigated by one refrigerating engineer, who reported that the trouble was traceable to the presence of magnesium chloride in the calcium brine. It was claimed that the magnesium chloride in combination with the water formed hydrochloric acid. Of course, if this were true, the acid undoubtedly would eat the iron pipe.

We replaced the mixed calcium and magnesium chloride with straight calcium, but the next season's run developed fully as many defective coils as before Advice was received from other sources that the trouble was due to the use of brass valves in the line, the statement being made that this set up electrolytic action. Acting on this suggestion, all the valves were replaced by iron ones. Nevertheless the corrosion went on just the same.

In making the repairs at this time, it was decided to change the plan of brine circulation. In the sketch is shown, diagrammatically, the system as installed. Here the brine, leaving the tank, was forced by the pump through the cooling coils. After passing through the coils, the brine was discharged into the tank by an overhead open pipe, as shown. The discharge pipe was lengthened until it was submerged about two feet below the level of the brine in the tank. To our surprise, no corrosion took place after this change. On making inquiry, we were informed by several engineers that the corrosion had been caused by the air entrained in the brine as it splashed out of the discharge pipe. This air, or at least the free hydrogen in it, had produced the rusting. This may be the cause of most of the corrosion experienced in power plants.

Newark, N. J.

J. CASS.

CORRESPONDENCE

Humanizing Engineering Formulas

In the Nov. 8 issue of *Power*, page 736, Mr. Bancroft criticizes my article, "Humanizing Engineering Formulas," published on page 302 of the Aug. 23 issue.

In reply might I suggest that Mr. Bancroft evidently has not found the true meaning of my article. Some people can read a book and by deep concentration visualize just what the author desires to express; many others would not be able to derive any practical benefit from the mere reading of the same book. If it is well illustrated, it would make a lasting impression upon the minds of the majority of us.

Formulas are tools with which the engineer must work. If he merely memorizes them without the knowledge of what they really mean, how can he expect to get the most out of his work?

All may not have the power of quickly visualizing the meanings of abstract terms, hence illustrations are an aid. Why use any diagrams in geometry or trigonometry? If it is admitted that they are an aid to the student, then why not illustrate our algebra and other branches?

C. W. THOMAS.

New York City.

Is Scratching Sound Due to Faulty Lubrication?

Referring to Mr. Collins' reply, page 651 of the Oct. 25 issue, to Mr. Holmquist's question, page 460 of Sept. 20 issue of *Power* regarding the scratching sound in his engine at a certain load: As this engine is not large, it would not be much of a job to remove the cylinder head and steam-chest cover and put the engine on the crank-end center and examine the cylinder walls. If the lubrication is not sufficient, the cylinder will be scratched, scored or cut, and near the cylinder head and perhaps on the piston will be found a dry powder "iron grits" and dust from cutting, which will occur with a dry cylinder. This dust will also be found in the steam chest around the exhaust ports, and the valve face and seat will be scratched and scored. This will increase rapidly after once started until the engine will wheeze and blow steam.

If the cylinder walls are smooth and bright, with little or no signs of scratches, there will be signs of oil on the inside of the cylinder head, also on the piston. The same condition will be found in the steam chest. If the oil is of poor quality, there will be little or none adhering to these parts and the walls of the cylinder will be brighter in appearance, and when touched with the tips of the fingers they will have a dry feeling instead of a slightly greasy, sticky feeling as is the case with good lubrication.

Lack of lubrication will cause the cylinder to be scratched and scored, but there will not be any scratching sound. When the cylinder reaches such a stage as to require reboring, a grunting sound will be heard.

The fact that a scratching sound occurs when the engine is carrying but 30 amperes, shows that the engine is then much underloaded. The point of cutoff is so short in the piston stroke that a vacuum is formed in the cylinder before the piston reaches the point in its stroke where the exhaust valve opens for release, and if there is the slightest room for the exhaust valve to lift from its seat, it will do so and will admit air to the cylinder if exhausting to the atmosphere; if exhausting to a condenser, it will have a wheezing, scratching sound all the time because of the high velocity at which the exhaust steam rushes into the vacuum in the condenser.

If the valve is of the slide-valve type, the boiler pressure on the back will hold it to its seat unless it is balanced or run under a pressure plate, but there will be some sound as the air rushes into the cylinder to destroy the vacuum when the exhaust valve opens. This will somewhat resemble a scratching sound at the engine cylinder, but there will be a different sound at the end of the exhaust pipe.

As to changing the lubricator to feed above the separator, I would not do it, as most of the oil would be merely carried out with the drip from the separator. The connections shown in the original illustration are good if the discharge from the lubricator extends about ½ or 1 in. beyond the inside of the steam pipe.

Cambridge, Mass. R. A. CULTRA.

Wilson Plant Cylinder-Head Explosion

Referring to the Wilson-plant cylinder-head explosion illustrated on page 542 of the Oct. 4 issue of *Power*, the drawing shows that all the branch pipes from the main steam header leading to the engines are horizontally in the same plane as the header. If the tees for these branch pipes had been arranged with the branches pointing vertically and the pipes bent into a horizontal direction toward the engines, I believe this accident would not have occurred.

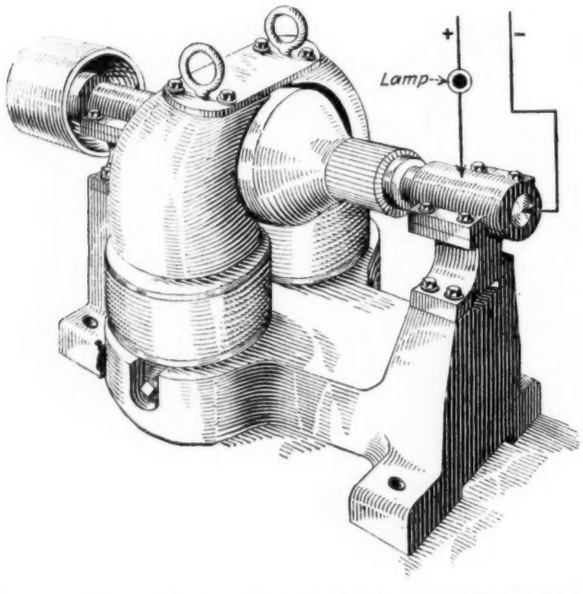
With such arrangement the water of condensation, before it can be blown over to the engines in any quantity, builds up a certain amount of head in the main, which compels the water to flow back to the separator. Insurance companies should insist on this method of arranging steam piping.

C. O. THOMAS.

Montreal, Que., Canada.

Using a File on Bearings

I quite agree with E. E. Long in the Nov. 1 issue of *Power*, in his comments on "Using a File on Bearings," that "the more common-sense step to take is to find out why a bearing lacks oil and why filing tends to improve the lubrication." In a properly designed bearing, lubricated with a good grade of oil, there is a



LAMP CONNECTED TO GENERATOR SHAFT AND BEARING

very definite film of lubrication established between the shaft and the bearing surface.

I call to mind one case of making a crude test on such a film in the bearings of a 5-kw. belt-driven generator, which operated at 2,400 r.p.m. The machine was stopped and a test lamp connected from the bearing housing to the shaft, as in the figure. Of course, when the machine was standing still the oil film was destroyed and the lamp lighted up to full candlepower. When the machine was started the lamp began to dim, and when full speed was reached it went out entirely, showing that the oil film was sufficient completely to insulate the shaft from the bearings. This machine had been in service at that time for 25 years, and as far as I could find out had the original bearing in it, and apparently not in the least worn. These undoubtedly were fortunate bearings to be in operation so long a period without being allowed to run dry a number of times. Although this may be a small machine, it nevertheless shows what may be expected when a bearing is properly designed and lubricated. After 25 years of operation the shaft must have been polished as highly as it was possible, but the application of a file to the shaft was not necessary for the establishment of an oil film.

Another thing that I have noticed, more particularly with motors, is that the size of the shaft and the size of fuse in the circuit have considerable influence on what may be expected if a bearing happens to run dry. If the shaft is small, as in some of the cheaper grades of motors on the market, should a bearing run dry the shaft will invariably cut into the bearing metal until the armature is down on the polepieces. This, of course, means replacing the bearing and in some cases repairing or rewinding the armature. On the other hand, with a motor having a good stout shaft in it and with the circuit properly fused, a dry bearing will frequently blow the fuse before the bearing is seriously injured. The writer can call to mind several occasions where this was the case with direct-current motors. Of course, with alternating-current motors this would probably not be true. On account of the small air gap between the rotor and stator any slight wear will allow the former to rub on the latter. However, the experience with direct-current machine shows that a good substantial shaft in a motor is a desirable feature.

Boston, Mass. CHARLES A. ARMSTRONG.

"Engineer" or "Gold Digger"?

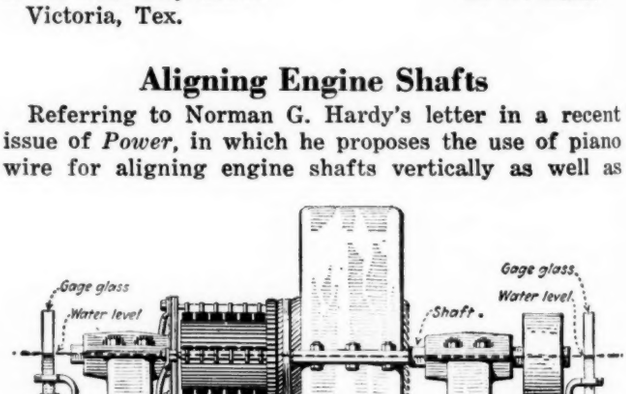
I am at a loss to know just why Mrs. Whitney pictured "The Engineer" as a stooping man with a shovel in his hand at a coal pile, as illustrated in *Power* for Nov. 1. Surely, it does not require gray matter to handle a shovel, as it does to construct railroads, battleships and large factories manufacturing commodities which the world uses. I believe that men doing the latter kind of work are not only called engineers, but are compelled to be; otherwise they would not retain their rank in a profession that requires as much education as any other.

If the title of the statue were omitted and it were left to the general masses of men to supply the name, I should imagine that it would be such as "The Coal Miner," "Gold Digger," or "Frontier Farmer Clearing His Land of Boulders and Rocks." It could, of course, be a "Coal Passer in a Power Plant," in olden days before the educated, trained and perfected mind of the engineer invented our modern coal stokers; it could be a fireman, but not an engineer. Engineers are paid as are physicians, not so much for what they do manually as for what they know. H. W. ROSE.

Victoria, Tex.

Aligning Engine Shafts

Referring to Norman G. Hardy's letter in a recent issue of *Power*, in which he proposes the use of piano wire for aligning engine shafts vertically as well as



HOSE AND WATER-GLASS SHAFT-ALIGNING DEVICE

horizontally, I submit herewith a method that is more accurate and simpler.

The sketch shows how any ordinary mechanic can quickly align any shaft vertically without the use of complicated devices or mathematics. Obtain two ordinary gage glasses, insert one in one end of a rubber hose and the other in the other end of the same hose, and then fill the hose with water, as indicated in the

sketch. This provides a leveling apparatus that is accurate, and one that is limited only by the length of the hose.

This level can be utilized not only for aligning shafting, but for erecting or correcting foundations, for determining the horizontal plane or in connection with almost any construction work where correct leveling is required.

Newark, N. J. W. F. SCHAPHORST.

Some Observations on Lubrication

Most of us have had experiences similar to those of A. L. Drew, C. P. Carvin and A. P. Jameson and have found remedies and gained experience into the bargain. The fact that changing the oil of a bearing that is heating often overcomes the difficulty emphasizes a truth often overlooked; namely, that an oil filter is a good investment on the score of safety to machinery as well as for economy of lubrication.

It is always cheaper to use oil over and over again than to use it once. A circulating system with a good filter permits oil to be used 500 times or more. In employing a circulating system it is well to remember that an oil of lower viscosity suffices. An oil that emulsifies does not filter well.

A good oil does not "wear out" mechanically, as it is often supposed to do. It does change color, however, becoming darker; it also changes in specific gravity and viscosity. The cheaper oils emulsify in the presence of water and become acid under the influences of air and heat. Rapid circulation of oil and, consequently, frequent filtering and cooling lengthen its life and so reduce the likelihood of bearing troubles. Filtering takes off suspended matter and removes dirt and water.

Many bearing troubles often looked upon as inherent to the machine are really due to the choice of an improper oil. Viscosity, which is the internal friction or resistance to flow of an oil, decreases with increasing temperature. As a bearing gets hotter, the oil tends to become less effective as a lubricant if the correct viscosity existed at lower temperatures. The effect is cumulative. Viscosity is generally determined at a temperature of 100 deg. F., which is well within the range of most bearings. The fact in mind, however, is that as the temperature of the bearing rises, the lubricating ability of the oil decreases. The temperature of the bearing is not a safe guide to the actual temperature of the oil film interposed between bearing and journal. The oil temperature is always higher.

One sometimes finds machines that "have never been the same" since overhauled or repaired. This may often be traced to the time when new bearings were installed. Sometimes the bearing is made too snug a fit, thus leaving insufficient space for the oil film upon which the shaft is supposed to float. The radius of the journal should always be less than the radius of the bearing so as to afford space for an oil film, varying in thickness with the diameter of the bearing. A common mistake is to cut the bearing grooves in the wrong place so that the oil is not sucked readily into the under side of the shaft, or so that the oil does not spread evenly over the entire bearing surface. This means improper lubrication, excessive heating, rapid decrease in viscosity and reduced oil circulation.

With the forced circulating system, supply pipes sometimes become clogged or the entrance to the bearing becomes partly choked. The flow of oil is thus restricted. Increasing the rate of circulation passes a larger amount of oil through the bearing (which is one way of lowering the temperature), but it also tends to wash out obstructions and accumulations that are gradually building up. Moreover, it means lower bearing and oil temperatures.

The use of graphite often solves a serious problem where a bearing is beginning to overheat, and whatever steps are taken must be taken without interrupting the oil supply or shutting down the machine. The admixture of deflocculated graphite to lubricating oil noticeably improves the lubricating properties of the oil. The graphite appears to build up depressions in the frictional surfaces and so creates smoother rubbing surfaces. In this way the use of graphite may prevent the abrasion and seizing of bearings. Only a little graphite should be used.

Graphite may be used to advantage where other conditions exist. For example, an oil, that would ordinarily be discarded as worthless will be found to have a new lease of life by the addition of a little graphite, about one-half of one per cent by bulk. In other cases an oil that is really too thin for the job may be the only kind available. Mix a little graphite with it and it will suffice, and less oil will be necessary than if the oil were used alone.

Static friction is sometimes a serious matter with heavy machinery and is radically less where a little graphite has been fed to the oil before the rotor ceased revolving previous to shutting down. Although the oil may have been squeezed out, the rubbing surfaces are smooth with graphite. The graphite also seems to hold the oil, but it may clog up oil grooves and holes and so interfere with the supply of oil and the conduction of heat that accompanies it. K. RANKIN.

Chicago, Ill.

Remedy for Static Electricity

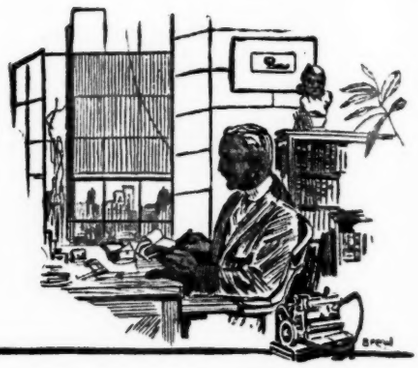
In answer to C. N. Peterson's inquiry on page 651 of the issue of Oct. 25, asking for a suggestion as to how to prevent the annoyance of static electricity in a belt driving a lineshaft from the flywheel of an engine, I suggest as a simple and good remedy to fasten near the belt a number of sharp metallic points that are connected with the ground.

This may be done by driving a number of sharp tacks through a piece of tin, or soldering some small wires to a large one, and fastening the row of points near the pulley so as to be within an inch of the belt. Another method is to stretch a wire lengthwise of the belt and a few inches above it, and still another is to fasten a bundle of fine wires, such as are used in lamp cord, a short distance above the belt. Any of these devices will take most of the electricity from the belt, if electrically connected with the ground and if the points are close enough to the belt. JAMES K. BIRD.

Adamston, W. Va.

The manufacture of power is an industry in itself. Air, fuel, water and labor are the raw products employed in producing the finished product. It is therefore necessary to employ suitable instruments by which the cost of the finished product can be determined. Without them the manufacturer of power is attempting to carry on his business without a production cost sheet.

QUESTIONS AND ANSWERS



Changing Speed of Throttle Governed Engine

How is a change made in the running speed of a throttle governed engine that is equipped with a Waters throttling governor? R. W. C.

A moderate change of speed can be made with this governor by loosening the wing check nut at the top of the governor and adjusting the wing head screw to raise or lower the balanced throttle valve of the governor for admission of more or less steam. If the desired amount of change of engine speed cannot be thus obtained, speeding up the governor with respect to the engine speed, by employing a larger governor driving pulley on the engine shaft, or reducing the diameter of the governor receiving pulley, will require slower speed of the engine to cause the governor to close the valve and thereby regulate the engine to lower running speed; and reducing the size of the governor driving pulley or increasing the size of the governor receiving pulley will require a higher speed of the engine to reduce the valve opening and thereby result in regulation with higher speed of the engine.

Trouble in Operating Lower-Pressure Centrifugal Feed Pump

We have a centrifugal pump driven by an electrical motor for returning hot water to a low-pressure boiler. The supply to the pump is obtained from a closed receiver into which the water is discharged by a trap. Since our plant was moved to the present location the pump will not work against a boiler pressure of 10 lb. or more, but in the old place it pumped against a pressure as high as 35 lb. What may be the trouble and the remedy? R. H. S.

Failure of the pump in the new situation must be due to a difference of the operating conditions. For uniformity of the suction pressure the receiving tank should have a vent pipe open to the atmosphere. Such a vent may be carried to a point outside of the building or to a place where the discharge of vapor is not objectionable. A closed tank may become steam-bound from leakage of the trap valve. The tank should be provided with a glass water gage to show whether there actually is water in the tank for supplying the pump. The pump should be at least three feet below the bottom of the receiver; otherwise, in pumping hot water the pump is likely to become steam-bound from the water bursting into steam and filling the pump case with vapor in place of "solid" water. If the pump is to be run continuously, its discharge should be kept throttled down to insure a head of water in the receiving tank, or the pump may become steam- or air-bound while running with an insufficient supply to its suction and would require venting or priming to make it pick up promptly. If the setting and operating conditions mentioned have all been complied with and the pump fails to operate in the new as well as in the former location, the trouble may be due to driving it at a different number of revolutions per minute.

Required Size of Aperture to Discharge Output of Boiler

When a return-tubular boiler 72 in. in diameter, 18 ft. long, is fired hard enough to evaporate 4,500 lb. of the feed water per hour into steam at 100 lb. gage pressure, what size of hole in the shell would discharge the steam to the atmosphere as fast as it was generated in the boiler? J. F. G.

The weight of steam generated per second would be $4{,}500 \div (60 \times 60) = 1.25$ lb. Napier's approximate rule for the weight of dry saturated steam discharged per second through an aperture, when the final absolute pressure is less than about 58 per cent of the initial absolute pressure is: Flow in pounds (discharged per second equals absolute initial pressure per square inch multiplied by the area of the aperture in square inches divided by 70, or area in sq.in. = 70 × wt. in lb. per sec. ÷ absolute initial pressure. Taking the absolute pressure of the atmosphere as 14.7 lb. per sq.in. and the boiler pressure of 100 lb. gage as $100 + 14.7 = 114.7$ lb. per sq.in. absolute, the absolute pressure on the discharge side of the aperture would be less than 58 per cent of the initial. Substituting in the Napier formula gives, Area of aperture $= 70 \times 1.25 \div 114.7 = 0.762859$, or $\sqrt{\frac{0.762859}{0.7854}} = 0.98$ in. diameter. That is to say, as fast as the boiler generated steam at 100 lb. gage pressure, the steam could be discharged through a hole 1 in. in diameter.

Pressure Exerted on Disc of Globe Valve

A 6-in. globe valve has a handwheel 12 in. in diameter and the stem threads measure four to the inch. Neglecting friction, if a man exerts a force of 150 lb. at the rim of the wheel (a) what total pressure does the handwheel exert on the disc; (b) what is the difference in total pressure on top and under the disc with 250 lb. per sq.in. in steam pressure under the disc and atmospheric pressure on top; (c) what is the pressure per sq.in. of contact surface of the seat if the seating surface measures $6\frac{1}{8}$ in. inside diameter and $6\frac{3}{8}$ in. outside diameter? J. S. G.

(a) The force 150 lb. exerted tangentially at the periphery of the handwheel for a revolution would develop $\frac{12}{12} \times 3.1416 \times 150 = 471.24$ ft.-lb. If the stem threads measure four to the inch, then for a complete revolu-

tion the disc would be moved $\frac{1}{4}$ in. or $\frac{1}{4} \div 12 = \frac{1}{48}$ of 1 ft., and the pressure exerted by the stem on the disc would be 471.24 ft.-lb. $\div$ $\frac{1}{48}$ ft. = 22,619.5 lb.

(b) With a steam pressure of 250 lb. per sq.in. gage under the disc, the force of the steam tending to raise the disc from its seat would depend on the inside diameter of the seating surface. Under (c) it is stated to be $6\frac{1}{8}$ in. For that inside diameter of seating surface the disc area exposed to steam pressure would be $6\frac{1}{8} \times 6\frac{1}{8} \times 0.7854 = 29.465$ sq.in. As a pressure of 250 lb. per sq.in. gage is an actual pressure of 250 + 14.7 = 264.7 lb. absolute, the actual force of steam tending to raise the disc would be 29.465 $\times$ 264.7 = 7,799.4 lb. If as per (c) the outside diameter of the seating surface is $6\frac{3}{8}$, or 6.1875 in., and the seat is absolutely tight for its whole width, the disc area subjected to atmospheric pressure holding the disc to the seat would be 6.1875 $\times$ 6.1875 $\times$ 0.7854 = 30.07 sq.in. The pressure of the atmosphere is 14.7 lb. per sq.in. hence the pressure exerted by the atmosphere on top of the disc holding it to the seat would be 30.07 $\times$ 14.7 = 442.01 lb., and the total pressure on top of the disc would be 22,619.5 lb. exerted by the stem + 442.01 lb. by the atmosphere = 23,061.51 lb. Hence the difference of pressure holding the disc to the seat would be 23,061.51 — 7,799.4 = 15,262 lb.

(c) The net area of the seating surface would be 30.07 — 29.465 = 0.605 sq.in. and the pressure per square inch would be 15,262 $\div$ 0.605 = 25,226 lb.

Permissible Air Pump Clearance

In reciprocating dry air pumps used with condensers, how is it that very small clearance in the air cylinder can be avoided and still without trouble from the expansion of air contained in the clearance space when the piston starts on its suction stroke? C. N. F.

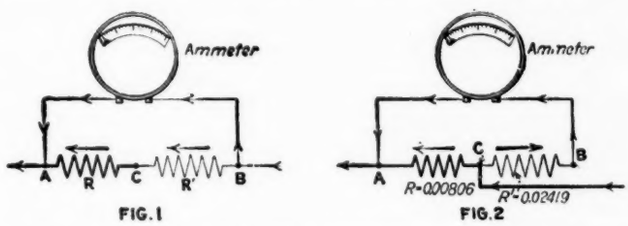
An air pump is, in fact, nothing but an air compressor which takes in air and uncondensable vapor at the pressure of the condenser, and compresses them to a pressure high enough to be discharged against the pressure of the atmosphere. At the end of a compression stroke the clearance spaces at the end of the cylinder remain filled with air at the pressure of the atmosphere. Then the piston proceeds on the return or suction stroke, and the air that was trapped in the clearance space expands with the increase of volume made by the displacement of the piston only until the pressure in the air-pump cylinder becomes so low from the expansion that the condenser pressure is able to open the suction valve. From that point to the end of the stroke, the space swept up by the piston becomes filled with air flowing in from the condenser. During the discharge stroke, air thus received from the condenser is compressed along with the clearance air that was expanded in the cylinder down to the pressure in the condenser.

The whole volume of air thus compressed to atmospheric pressure is discharged excepting the amount necessary to fill the clearance space, and all conditions are the same as those present at the beginning of the cycle. Hence, barring leakages, an air pump will remove some air and non-condensable vapor from a condenser so long as the clearance space of the pump will not hold enough air at atmospheric pressure to fill the clearance spaces, plus the volume swept by a stroke of the piston after that air has expanded down to the pressure existing in the condenser. The volume of air drawn per stroke from the condenser depends on the volume displaced by the piston after the clearance air has been permitted to expand to such a volume that its pressure becomes reduced to the condenser pressure, and the larger the air-pump cylinder that is provided for a given service, the larger may be the percentage of cylinder clearance.

Determining Resistance of Double-Capacity Shunt

Is there any formula for determining the resistances of a double-capacity shunt if the resistance of millivoltmeter and current for full-scale deflection of the meter be given? For instance, we want to make a double-capacity shunt for 5 and 20 amperes for a meter that has 4 ohms resistance and takes 0.04 ampere for full-scale deflection. P. J. S.

This problem may be solved by simple arithmetic from a consideration of the diagram, Fig. 1, which shows the meter connected to the two shunts in series. Consider first the connection for 5 amperes, which would be those shown in the figure. With full-load current in the shunt the volts drop E across points A and B must equal



FIGS. 1 AND 2. AMMETER CONNECTED TO DOUBLE-CAPACITY SHUNT

the current through the meter, times the meter resistance in ohms, or E = 0.04 $\times$ 4 = 0.16 volt. The total current, 5 amperes, will divide 0.04 ampere through the meter and 5 — 0.04 = 4.96 amperes in the shunt RR'. The total resistance of the shunt RR' must be equal to the volts drop E, divided by the current I, or $RR' = E \div I = 0.16 \div 4.96 = 0.03225$ ohm. This is the total resistance of both shunts.

Now, calling the 20-ampere shunt R, it is evident that the resistance of shunt R' will be 0.03225 — R: and upon changing the connection to point C, as in Fig. 2, resistance R' is in series with the meter, instead of acting as a shunt, in Fig. 1. The same current, 0.04 ampere, as before is required through the meter for it to reach full-scale reading, therefore the drop across points A and C must be $E = 0.04 \times [4 + (0.03225 - R)] = 0.16129 - 0.04\,R$. The current in R will be 20 — 0.04 = 19.96 amperes, and the volts drop will be $E = I\,R = 19.96\,R$. These two drops must be equal; that is, $19.96\,R = 0.16129 - 0.04\,R$. By transposition $19.96\,R + 0.04\,R = 0.16129$, or $20\,R = 0.16129$, from which $R = \frac{0.16129}{20} = 0.00806$ ohm. Then $R' = 0.03225 - R = 0.03225 - 0.00806 = 0.2419$ ohm.

In the actual construction of the shunt be sure to select manganin of sufficient cross-section to prevent overheating, and solder the ends of the strip well into copper lugs. After an approximate adjustment of the foregoing values of R and R' the instrument should be connected in series with an accurate standard and the two ranges adjusted—first the heavy-current reading and then the lower-current range.

Hydro-Electric Power in Pennsylvania*

Although Pennsylvania Has a Relatively Cheap Coal Supply, E. H. Sniffin Believes That, Ultimately, the Complete Development of That State's Water Power Is Inevitable, for Reasons of Physical Necessity, To Supply Sufficient Power to Congested Districts

PENNSYLVANIA is conspicuously a coal state. It has already produced about six billion tons of bituminous coal, with enough still in the mines to last, at present rate of production, some 500 years. About the same tonnage of its anthracite has been mined, with perhaps another hundred years to go. Its portion of the nation's total fuel currently mined and supplied is about 46 per cent. Its potential water power, however, is not very large, being estimated at something like 1,250,000 hp., or about 2 per cent of the country's total. The country as a whole has developed about 15 per cent of its available water-power resources. Pennsylvania has developed 375,000 hp., or about 30 per cent of its total.

We see, then, that even alongside this plentiful and relatively cheap fuel supply, there has been a fair amount of hydro-electric development, though it has been a very small part of the total power generated. The manufacturing plants alone are using between five and six million primary horsepower.

Possibilities of Further Development

What are the possibilities of further hydro-electric development within the borders of the state? Or perhaps not quite within its borders either, for the Delaware River basin appears to afford the greatest possibilities of them all, and as this involves also the States of New York and New Jersey, there would be required the joint action of all three states. Including the Delaware there is within the state the following water-power sites on most of which preliminary surveys have been made.

Delaware River, 300,000 hp.—The plan involves utilizing the fall of the river for about 125 miles of its length, from Hancock, N. Y., to below Belvidere, N. J. Within this distance there is a fall of 675 ft., of which 527 ft. would be used by ten power plants giving a minimum output of 300,000 hp. for 12 hr. a day.

Clarion River at Foxburg and Clarion, 224,000 hp.—Here at two sites would be required two dams about 250 ft. high, providing a usable storage capacity of forty billion cubic feet, sufficient to give a continuous uniform flow throughout the year equal to the average stream flow.

Susquehanna River, 160,000 hp.—Two sites have already been developed on this river, one at York Haven, the other at Holtwood. It is proposed to construct a still larger plant at Conowingo, near the river's mouth. The river flow varies from 3,000 to 600,000 second feet.

Susquehanna River, about two miles south of Millersburg, Dolphin County, 2,500 hp.; Northbranch of Susquehanna River, one mile below Nanticoke, 2,000 hp.; Juanita River, about one mile above the mouth, 7,000 hp.; Rapid Run, a tributary of Buffalo Creek, Union County, 925 hp.; Chillisquaque Creek, Northumberland County, just above the mouth of the stream, 575 hp.; Big Sandy Creek, a tributary of Cheat River, 25,000 hp.; Youghiogheny River, at Ohio Pyle, Fayette County, 9,600 hp.; West Branch of Susquehanna River, at Williamsport, 2,100 hp.; Shohola Creek, Pike County, a tributary of Upper Delaware River, 15,000 hp.; Crooked Creek, a tributary of Allegheny River, 20,000 hp.; Cowanshannock Creek, a tributary of Allegheny River, about one mile above the mouth, 8,000 hp.; West Branch of Oil Creek, at Riceville, Crawford County; 60 hp.; Wallebaubeck Creek, a tributary of Lackawaxen River, 15,000 hp.; North Branch of Susquehanna River, about two miles below the Borough of Towanda, 5,000 hp.; Upper Delaware River, a series of low developments in conjunction with storage reservoirs in New York and Pennsylvania; capacity unknown.

In addition to the developments here listed, there are a number of smaller developments of which the possible capacity is unknown.

The characteristics of all the streams is the widely variable run-off at different seasons of the year. There are no snow-capped peaks to hold the water, nor are there considerable facilities, with the gradual slope of country, for extensive storage. There are too many railroads and settled communities to permit of flooding much of the land. For the most part, then, the water must be used as it comes down-stream. That means an exceedingly variable supply. It means, undoubtedly, that no such project would be tenable except as a new source of power to be fed into existing electric distribution systems served in the main by steam stations, for the power supply to our communities must be adequate and constant. The ideal condition would be where the steam station was the base-load plant at periods of low water, the hydro helping out on the peak loads, while at high-water periods the base load would transfer to the hydro plant, the steam coming in on the peaks.

Comparative Costs of Water Power and Steam-Generated Power

It is the popular notion that water power is cheap, and it takes very little labor to run the plant. The machinery lasts a long time, so the maintenance is low. Further, there is not much room to improve the efficiency; therefore, the amortization is a small factor. But when you come to spend $200 or $300 per kilowatt, and sometimes more, for plant construction and equipment alone, then have to transmit the power over long lines to market, the fixed charges will be something like 85 per cent of the cost, and in Pennsylvania, with its relatively cheap coal, it becomes difficult to compete with the cost of producing power with a modern steam plant of good size, located near its market. Whether the power is generated by water or by steam, the distribution cost is the same and is in fact more than the total cost of steam-plant operation, including fixed charges. Our utility companies of today which supply the larger communities, using steam power only and paying reasonable prices for their coal, are receiving an average revenue of between 2 and 3c. per kw.-hr. It is the cheapest commodity the people use, and yet with these low rates which the communities enjoy, the public-utility business is one of the soundest and most stable of all our industries. We are, therefore, not driven to our streams to relieve a burden of public cost. We must, however, use these streams sooner or later for reasons of physical necessity.

The more our great systems of electric-power distribution are extended and interconnected, the more valuable will become these hydro-electric plants, constructed to fit the conditions, feeding in what they can and where they can. Ultimately, their development is inevitable. It will not be a question of cost. Our congested communities will need so much power that it will not be possible to mine, transport and store the coal to take care of them. We have had object lessons on that score during the last few winters when, with the country at its peak of fuel consumption, many communities could hardly count on their supply a day ahead. The electric-power consumption of this country per capita has doubled every five years for the last two decades. It will soon be a question not how cheaply we can generate power, but how plentifully we can supply it, for it must be had. Our state governments, and especially the Federal Government, must do everything possible to encourage capital and enterprise in that direction.

*Abstract from an address before a recent meeting of the Pennsylvania State Chamber of Commerce, by E. H. Sniffin, manager, Power Department, Westinghouse Electric and Manufacturing Company.

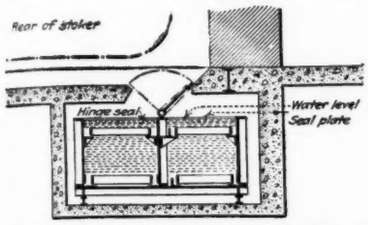
Condensed-Clipping Index of Equipment

Patented Aug. 20, 1918

Conveyor, "Combusto" Ash

International Combustion Engineering Corp., New York City

"Power," Aug. 30, 1921



This ash conveyor consists of a drag-link conveyor working in a trough of water and is placed beneath that part of the furnace where the ashes are dumped. The hot ashes and clinkers are quenched and the clinkers break up on reaching the water. In a standard installation two conveyors are placed in separate troughs with a hinge between them for diverting the flow of ashes into either the one or the other conveyor. The ashes and clinkers pass through the return chain into the lower operating part of the chain. Air leakage from the sides of the ashpit is prevented by two steel seal plates which extend into the water in the trough. The water level is maintained by a float valve which controls the make-up. Ashes are discharged into an ash hopper for removal. Maximum travel of the conveyor is 17 ft. per minute.

Pump, Rothweiler

Rothweiler & Co., 2962 First Avenue South, Seattle, Wash.

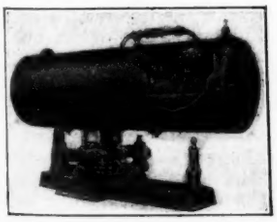
"Power," 1921

This pump has a special bushing that fits into the regular ¾-in. opening in all steel drums, also in a 1-in. hole drilled in a wooden barrel. It has a special swivel, anti-drip spout; the spout is turned up after use, which prevents all drip and waste of oil.

Pump, Farnsworth Condensation

Farnsworth Co., Conshohocken, Pa.

"Power," 1921

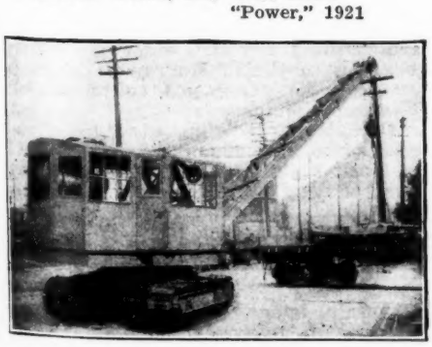


In this condensation pump the tank is removable from the supports, also the pipe that carries the steam to the top of the tank. The valves are of the poppet type and pressure is on top of the seat. The steam pressure does not touch the stuffing box that operates the valve, as there is a water seal in the lower chamber between the stuffing box and the steam valve. The tank is carried on adjustable roller bearings. Proper alignment of the stuffing boxes eliminates leaks. A ball-bearing oil-cushion dashpot and bumper combined absorbs the shock of tilting. An automatic air-relief valve is fitted to the pump. Cold-water sprays in the condenser type of machines are controlled automatically with a valve, so that while pressure is on the tank forcing the low pressure condensate out, the sprays are automatically shut off.

Crane Crawling Tractor

Industrial Works, Bay City, Mich.

"Power," 1921

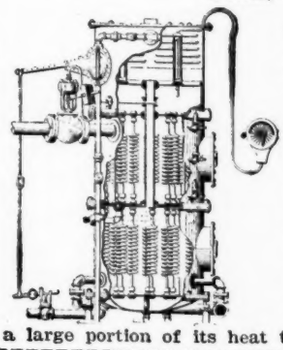


A full-revolving tractor crane that can be operated independently of rails. Built in two types, with a capacity of 20,000 lb. at 12-ft. radius, equipped with continuous crawling tractor belts, and a capacity of 18,000 lb. at 10 ft. radius, equipped with four broad-gage tractor wheels. They can be equipped to handle a hook and block grab bucket, drag scraper bucket, wood grapple, clam-shell bucket and a shovel dipper.

Deactivator Deaërating Apparatus

Anti-Corrosion Engineering Co., Inc., 117 West 54th St., New York City

"Power," Aug. 30, 1921

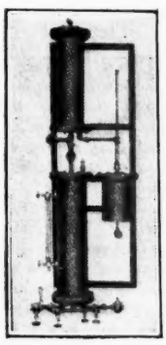


This apparatus is designed to prevent pipe corrosion if constructed with an exchanger booster heater, using low-pressure steam and a deaërator. The two lowest sections are porcelain-lined and the coils, pipes, pans, diaphragm, etc., are of copper or of coated bronze. Water passes through the coils, in which it is heated by the steam from the hot water that is leaving the deactivator. The incoming water also passes through the upper coils in which the water is raised to about 207 deg., the temperature being regulated by a thermostat. At this temperature the water gives up its dissolved gases as it falls over the cascade plate. Heated water is taken from the bottom of the apparatus in which it gives up a large portion of its heat to the incoming cold feed water.

Evaporator Set, Distilled Water

Griscom-Russell Co., 90 West St., New York City

"Power," 1920

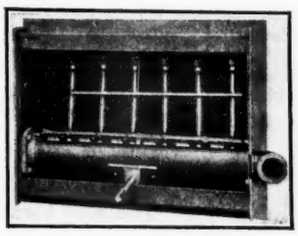


This complete evaporator set is for providing small quantities of distilled water. It consists of an evaporator containing coils of brass tubing to which steam is supplied. The vapor from this evaporator passes to a distiller and is condensed in the coils of the unit by circulating water which flows through the shell. If the distilled water is to be used as drinking water, it then passes through an aërating filter, but if it is to be used in a laboratory or in a manufacturing process, the filter is omitted. The set is compact and is mounted on an angle-iron frame with the piping and ready for the steam and water connections to be made to it. The dimensions of the complete set are 7 ft. high by 2 ft. 4 in. wide. It has a capacity of from 15 to 30 gal. of distilled water per hour, depending on the steam pressure available.

Soot Blower, Monarch, for Vertical Water-Tube Boilers

Monarch Soot Remover Co., Inc., 261 Franklin St., Boston, Mass.

"Power," Aug. 9, 1921

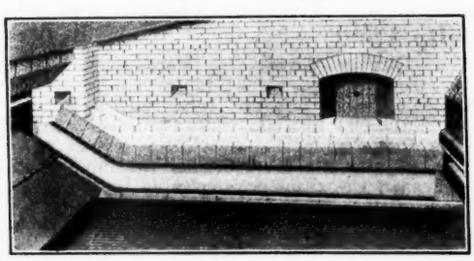


This vertical water-tube boiler soot blower consists of a number of soot-blowing nozzles, each having two openings. The direction taken by the streams are such that soot is blown from all portions of the tube as the nozzles are moved from one portion to another. The header to which the nozzles are connected is fitted with a gear that matches with a worm on the shaft, the latter being turned with a crank during the period of blowing. The nozzles are swung back out of the heat, and shutters protect them after blowing.

Waterbox, Green Sidewall

Green Engineering Co., East Chicago, Ind.

"Power," 1921



A new "sidewall" waterbox for chain-grate stoker furnaces is a device offered as a solution for the maintenance problems arising from furnace temperatures, and when installed the water boxes line the lower part of the furnace side walls as high as the top of the fuel bed and for the full length of the grate. They provide a surface in contact with the fuel bed to which clinker will not adhere. The waterboxes are connected into the boiler circulation by circulating and supply tubes accessible for cleaning

Clip, paste on 3 x 5-in. cards and file as desired

News in the Field of Power

Alabama Power Co. To Run Muscle Shoals Plant at Once

According to a statement given out by local officials of the Alabama Power Co., the 90,000-hp. steam plant at Muscle Shoals, which was leased from the Government by the company recently, will be placed in full operation by Dec. 1.

This statement was given out following the notice that the contract between the Government and the Alabama Power Co. had been signed in Washington. The lease is for one year and carries with it the right of the Government to end it at any time by giving 30 days' notice. The 30-days clause is to allow the Government to dispose of the entire Muscle Shoals project without being handicapped with the steam plant located near there.

The Alabama Power Co. needed the plant at Muscle Shoals for supplementing its other power and lighting plants for immediate demands upon them. The coal for operating the plant will come from the fields of Walker County, Alabama, and several hundred tons will be required each day. This will give employment to many miners that have been idle for some time, and it is estimated that about 200 men will be employed at the plant alone.

It is announced that the power companies of Georgia and of the Carolinas will take as much of this power as can be spared by the Alabama plants.

It is estimated, figuring on the Henry Ford plan, that the starting up of this steam plant at Muscle Shoals will give employment to 90,000 men in the States of Alabama, Georgia and the Carolinas. Many of the cotton mills in the Carolinas were unable to operate for the lack of electric power until a few weeks ago, when the Alabama Power Co. connected its transmission lines with those of Georgia and the Carolinas. Now the company is sending 10,000 kw. 400 miles away to the cotton factories of the Carolinas.

That Henry Ford should be given the lease on the Muscle Shoals project is the prevailing opinion in the vicinity of the plant. The daily mails are taking to Washington thousands of letters to Southern Congressmen and Senators, urging them to work for the Ford project. These letters are going from civic and commercial bodies and from many private individuals.

Western States Company Plans 100,000-Hp. Plant

The Western States Gas and Electric Co. has been authorized by the California Railroad Commission to put up a new hydro plant of 100,000 hp. capacity about ten miles above its present plant on the South Fork of the American River and to increase the capacity of its existing plant to about 56,000 hp.

In order that Therezopolis, a summer resort near Rio de Janeiro, may have electric light and other modern luxuries, it is planned to build a big hydro-electric power plant near there. When the plant is up, the city authorities ought to erect a brilliant electric sign showing that word THEREZOPOLIS.

Colorado River To Be Discussed at Riverside

An important conference is being planned by the League of the Southwest for Dec. 8-10, at Riverside, Cal. The development of the Colorado River will be discussed by a number of very prominent men, including Herbert Hoover, who is expected to deliver in person a message from President Harding. Governors of the states involved are to give their opinions, and Adam Beck, of the Hydro-Electric Power Commission of Ontario, is expected to present the argument for public ownership. The policies of the Federal Power Commission in the matter will be given by its secretary O. C. Merrill.

The A. S. M. E. Meeting

THE BIGGEST event on the power engineer's horizon next week is the annual meeting of the American Society of Mechanical Engineers at the Engineering Societies Building, New York, Dec. 5-9.

Although the keynote session will be "The Elimination of Waste in Industry"—the most vital topic that engineers can discuss—there will be fourteen features dealing particularly with power problems. The program was printed in "Power" for Nov. 22.

The papers that one hears are not the chief attraction of such a convention, however; they can be read afterward. What a gathering like this holds out is the opportunity to meet men from other sections, to trade one good opinion for another, to broaden one's viewpoint by listening to the discussions, to get a composite picture of things as they are. The man who goes to the A. S. M. E. meeting will go back to his work refreshed and strengthened, with a quicker, keener grasp of his problems.

The next best thing to going to the meeting will be to read "Power's" account of it, which will be full, authoritative and interesting. Watch for it in an early issue.

Stoker Manufacturers Ready To Co-operate

Representatives of the Stoker Manufacturers Association of America have tendered its services to the Department of Commerce and have expressed its willingness to co-operate in any way with the department so as to provide reliable information in connection with the manufacture of mechanical stokers. The representatives of the association who called on Mr. Hoover were M. Alpern, the president of the association, and R. Sanford Riley.

They also are interested in coal classification, which they discussed with officials of the Bureau of Mines. They urged that coal be sold and statistics collected on a B.t.u. basis.

Practical Refrigerating Engineers To Hold Four-Day Convention

The list of papers for the annual convention of the National Association of Practical Refrigerating Engineers, which is to be held Nov. 30-Dec. 3, at the Hotel Lorraine in Philadelphia, demonstrates the organization's purpose of putting its efforts on practical operating problems. A wide range of subjects will, nevertheless, be covered, as may be seen from the following schedule of papers: Wet and Dry Compression; Absorption-Plant Operation; Engine-Room Logs and Plant Efficiency; Working Temperatures and Pressures; Aftercooling of Liquid Ammonia; Safe and Sane Ice and Refrigerating Machinery Construction; Ammonia Compressor-Rod Packing; Present Status of Raw-Water Ice Manufacture; Labor-Saving Devices; Selection of Prime Movers; Oxyacetylene Welding and Cutting in the Refrigeration Plant; Direct Spray System for Cooling and Dehumidifying Air; Future of the Refrigeration Engineer; Education and Engineering; Water Treatment for Raw-Water Ice; General Refrigeration-Plant Practice; Use of Electricity in Refrigeration Plants; Improved Circulation in Ice Making.

In addition to the reading and discusing of papers there will be an exhibition of light machinery, accessories and supplies used in refrigerating plants or in connection with such work.

This is the first convention of this association to be held in Philadelphia, or even in any of the Eastern States, and so offers a good chance for refrigerating men in the East to become acquainted with the organization. Increasing activity has been shown by the association in the last year or so, one indication of which is a course of study in practical refrigeration that it has prepared, and which may be taken by correspondence or in connection with class work.

Information about the course or any other work of the association may be obtained from the Secretary, Edwin H. Fox, 5707 West Lake St., Chicago, Ill.

Southern Power Company To Add To Its Capacity

By means of two new water-power plants on the Catawba River, the Southern Power Co. plans to add 131,250 kva. to its existing capacity. Announcement has recently been made that the contract for the waterwheels has been let to the S. Morgan Smith Co., and for the generators to the Allis-Chalmers Company.

One plant will be in the nature of an addition to the company's existing plant at Great Falls, S. C., and will be called Great Falls Power House No. 2. Present plans for this station call for three units, each having 18,750 kva. capacity and operating under a 72-ft. head. The other plant, which will be entirely new, will be called the Mountain Island station and will be built about twelve miles from Charlotte, N. C. This plant will have four units of the same design and capacity as those of the other station, but operating under a head of 80 feet.

Bureau of Standards Seeking Research Engineers

Competitive examinations are being held by the United States Civil Service Commission. The positions and salaries are: **Engineer**, $2,800 to 4,000; associate engineer, $2,000 to $2,800; assistant engineer, $1,500 to $1,800. The scope of the bureau's work is wide, including electrical, mechanical, civil, and chemical engineering, as well as specialized lines in other branches. The educational value of the positions to be filled is emphasized by the bureau, which calls attention to the opportunity of obtaining valuable experience in its work and to the advantages of lectures, literature, etc., which are available in Washington.

For the position of junior engineer, written examinations that must be attended in person will be held throughout the United States on Jan. 11, 1922, and, if necessary, on March 8 and May 17. For the other positions, however, it is only necessary to write for the application blank and fill it out properly. Before sending for the application, it would be best to write the Civil Service Commission at Washington, D. C., for a circular of information telling about the examinations and the positions to be filled.

Ford's Muscle Shoals Offer Probably To Be Accepted

While the newspapers have recently announced with considerable assurance that Secretary Weeks has agreed to recommend acceptance of Henry Ford's Muscle Shoals offer and that the Harding Administration has decided in favor of it, the matter is still under discussion at this writing and cannot properly be considered as settled. It may be said, however, that it is understood in Washington that the offer is to be accepted in revised form. Just what revisions there will be has not been made public.

Mr. Ford was in Washington on Nov. 18 and conferred at length with Secretary Hoover, later being called to the bedside of Secretary Weeks, who was ill. Mr. Weeks is reported to have suggested calling in Thomas Edison to help in estimating the cost of completing the Wilson dam.

Final acceptance of the offer must be made by Congress, and it is understood that preliminary action has been taken toward putting the proposition before the Senate and the House as soon as Secretary Weeks has received a report on the cost of the work.

Will Corn Replace Coal?

The fact that some Middle-Western farmers have been burning corn because they could'nt stand the high coal prices has caused some comment in the newspapers recently, although, as a matter of fact, the thing has often been done before.

Secretary of Agriculture Wallace says that corn at 20c. a bushel is a cheaper fuel than coal at $10 a ton, and not only is this theoretically correct, but it is said that tests have shown the same results. Corn has about three-fourths the heat value of coal, and runs about 70 lb. per bushel. Therefore a ton would cost $5.72, and three-fourths of a ton of coal, which would have the same heat value, would cost (at $10 a ton) $7.50. The difference to the farmers in favor of corn, of course, is even greater than this, because they have the corn on hand and would have to pay for carting the coal.

F. F. Uehling, a combustion engineer, of New York City, wrote a letter to the *New York Times* on the subject recently, and said he thought the time would come when all fuel will be grown instead of mined. He said: "The very fact that farmers can even today afford to burn corn as fuel is not so startling after all, since undoubtedly the day will come when nature's storehouse will have become depleted of its fuel reserve, and then of necessity all fuel will have to be grown as required."

This seems to be a pretty strong statement, but some of those that look ahead more than ten years or so believe that there are possibilities in the way of using the luxuriant vegetation of the tropics as fuel, possibly by distillation for the alcohol it contains.

Bureau of Mines Studying Low-Temperature Coal Carbonization

The carbonization of coal at low temperatures has been the subject of extended study and experimentation in this country and in Europe, but according to the Bureau of Mines it is only recently that results have been obtained that can be used directly by carbonization engineers. The bureau has been active in this work and has recently issued a report of its investigation, which had the purpose of developing more economical methods of processing fuels than the well-known high-temperature method.

While the subject is not of great practical interest, the report might prove valuable to one engaged in a study of the distillation of coal. It is known by the serial number 2,292 and may doubtless be obtained upon application to the Bureau of Mines at Washington. It was prepared by Joseph D. Davis, one of the bureau's fuel chemists.

Development of Power from Umatilla Rapids Urged

It would be entirely practicable to develop a mimimum of 125,000 hp. and a maximum of 500,000 hp. from the Umatilla Rapids, on the Columbia River, 180 miles east of Portland, Ore., according to a report prepared by Lewis & Clark, of Portland, under the direction of the Umatilla Rapids Power Site Association, of Pendleton, Ore.

A 30-ft. dam is proposed, which would make available a head of from 27 to 33 ft. at all stages of the river. It is hoped that private capital can be secured for the project, or that the Reclamation Service will undertake it upon passage of the McNary Bill.

Argentina Needs Diesels

Tenders are again being invited by the Board of Sanitary Works of Argentina at Buenos Aires for a new generating station. Proposals must be in by Jan. 19, 1922, and are to cover erection of the plant and supply of the entire equipment. The principal equipment will be three four-stroke-cycle 375-hp. Diesel engines adapted to the burning of crude petroleum, and three three-phase alternators rated at 250 kw., 2,200 volts between phases, 50 cycles, at a power factor of 0.8.

Plans Differ for Developing St. Lawrence

From 1,450,000 hp. to 5,400,000 hp. should be developed from the St. Lawrence River, according to four different plans that were presented to the International Joint Commission in Ottawa recently.

W. A. Bowden, chief engineer of the Canadian Department of Public Works, and Colonel Wooten, the representative of the United States, proposed a power plant at the Long Sault, where 1,450,000 hp. would be developed, the remainder of the river being used as a ship canal.

The Hydro-Electric Power Commission of Ontario was in agreement with this plan, but suggested the possibility of developing an additional 100,000 hp at Morrisburg.

W. S. Connolly, the representative of the New York and Ontario Power Co., of Waddington, N. Y., proposed that 660,000 hp. be developed in a series of dams between Waddington and Morrisburg, and about 1,000,000 hp. by another series at the Long Sault.

Colonel Hugh L. Cooper, a New York consulting engineer, favored developing the river to its full capacity, which he estimated at 5,400,000 hp. in four stages.

Manitoba Power Company Building Hydro Plant

A hydro-electric power plant that is to have an ultimate capacity of 168,000 hp. is being constructed by the Manitoba Power Company, Ltd., at Great Falls, on the Winnipeg River. The initial installation will consist of two 28,000-hp. units operating under a head of 56 ft. The new plant will be tied in through a 17-mile transmission line with the Winnipeg Electric Railway Co.'s Pinawa hydroelectric plant.

A pictorial magazine of industry has made its appearance as *Industry Illustrated*, a monthly paper edited by John H. Van Deventer, formerly with the *American Machinist*, and published by the Engineering Magazine Company, of New York City. It sells at ten cents a copy, or one dollar a year. It is somewhat of a departure from current practice in that the text consists almost entirely of photographs.

No agreement is yet in sight in regard to the use of Shipping Board vessels in such a manner as to be of advantage in marketing more American coal abroad. Discussions between Secretary Hoover, Shipping Board officials and representatives of the operators are continuing. No party to the conference will venture a prediction as to the probability of a favorable outcome.

Explaining the application of his proposed 3 per cent sales tax to the Senate, Senator Reed Smooth, Utah, said it would yield $10,500,000 on anthracite coal and $20,655,000 on bitimunious coal during the calendar year 1922.

Members of the Boston sections of the various national engineering societies are considering the formation of some kind of local engineering council such as those that are being planned in several other cities.

New Publications

Salient Features of Electric Cooking and Heating. By Samuel S. Wyer, Hartman Building, Columbus, Ohio. Paper, 6 x 9 in., 32 pages.

A discussion of the economic and technical phases of the subject, with the conclusion that the domestic use of electricity for cooking and heating would be an expensive luxury and an unjustifiable waste of coal.

Design of Atmospheric Gas Burners, Technologic Paper No. 193 of the Bureau of Standards. Sold by Superintendent of Documents, Government Printing Office, Washington, D. C., for 15c.

A pamphlet covering the first part of an extensive investigation of the design of gas burners, going into considerable detail and giving the results of numerous experiments and observations.

Testing Large Scales — Technologic Paper No. 199 of the Bureau of Standards. Published by Superintendent of Documents, Washington, D. C. Price, 5 cents.

According to the Bureau's engineers the possible accuracy of large weighing scales is not generally known. This paper explains scientific methods of testing such scales with a high degree of precision.

Economical Utilization of Liquid Fuel. By Carl Norman. Published by the Engineering Experiment Station of the Ohio State University, Columbus, Ohio. Paper 6 x 9 in., 206 pages. Price $1.

This bulletin takes up a study of the available petroleum resources of the country, available substitutes for petroleum, the principal reasons for the existing shortage, and possibilities of relieving that shortage. It is mainly a compilation of previously published information, although there is included the results of a few original investigations of a theoretical nature.

Flow of Water Through Spiral Riveted Steel Pipe. Bulletin No. 8, published by the Engineering Experiment Station, Purdue University, Lafayette, Ind. Price 25c.

Results are given of an investigation on the flow of water through 4-, 6-, 8- and 10-in. galvanized spiral riveted steel pipe, which was begun in 1917 by civil-engineering seniors, and has now been completed by an associate professor and a research assistant, who are responsible for the figures. The object has been to determine the relation of friction loss to velocity in straight runs, with the flow both with and against the laps.

Annual Report of the Smithsonian Institution for 1919. Published by the Superintendent of Documents, Government Printing Office, Washington, D. C. Cloth, 6 x 9 in.; 557 pages. Price, $1.50.

Anyone that would be interested in learning of the organization and activities of the Smithsonian Institution will find full information on this subject in the first 120 pages of this book, where the Institution's work is described in considerable detail. The rest of the book is a general appendix comprising lectures, papers, translations, reports, etc., on a great variety of subjects having a general scientific interest. Practically none of these articles, however, has any connection with power problems.

Results of Some Tests on Manila Rope, Technologic Paper No. 198 of the United States Bureau of Standards. Sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 5c.

The results of tests of 368 specimens of manila rope from ¼ in. to 4½ in. in diameter are given in tables and charts. A formula that is based on these figures is given for estimating the breaking load for any size of rope. Until the free stock is exhausted, anyone may obtain a single free copy by addressing the Bureau of Standards at Washington.

Powers Practical Refrigeration. By Power Editorial Staff. Semi-flexible cloth; size 5¼ x 8¼ in.; 282 pages; 102 illustrations; 25 tables.

Probably less of a practical nature has been published in available form on refrigeration than any of the other branches of power engineering. Many volumes dealing with the principles of refrigeration have been offered to the public, but few authors have attacked the subject from the operating viewpoint. *Power* has devoted many columns to the subject of practical refrigeration, and as a result of the insistence of its subscribers this material has been collected and printed in book form. *Power* will supply this book in connection with new and renewal subscriptions.

Elevator Safety Code. Prepared and published by the American Society of Mechanical Engineers, 29 West 39th St., New York City. Paper, 6 x 9 in.; 93 pages. Price, 65 cents.

A proposed code of standards for the construction, operation and maintenance of elevator equipment, which is the result of about five years' work on the part of the society's Committee on the Protection of Industrial Workers, with the co-operation of the United States Bureau of Standards and the industrial boards and other organizations and individuals in many states. The divisions of the code are: Hoistway Construction for Passenger and Freight Elevators and for Dumbwaiters; Power Passenger Elevators; Power Freight Elevators; Hand Elevators and Hand Invalid Lifts; Dumbwaiters; Escalators; Operating Rules.

A. S. M. E. Condensed Catalogs of Mechanical Equipment. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York City. Cloth; 6 x 9 in.; 932 pages; Price, $4. One copy free to members of A. S. M. E.; extra copies, $3.

The annual directory of mechanical apparatus prepared by the American Society of Mechanical Engineers, this being the eleventh volume. Its scope includes: Power-plant equipment; testing, measuring and recording apparatus; power-transmission machinery; conveying, hoisting and transporting machinery; metals, alloys and other materials; metal-working machinery, machine tools and accessories; compressors, blowers, pumps, hydraulic machinery, industrial machinery, steel-plate work. The 648-page catalog section illustrates and describes the products of 495 manufacturers. There is included also a directory of 4,000 makers of mechanical equipment under 3,000 classifications, and a directory of 1,000 consulting engineers (A. S. M. E. members only) under 400 classifications.

Personals

Clement C. Smith is now superintendent of the Mengel Co., Jersey City, N. J. He was formerly with the Drake Smith Co., of Bristol, Vt., where he served two years as engineer.

O. G. Gillett and F. V. Whitney have been appointed superintendents of the South Meadow and the Dutch Point Stations, respectively, of the Hartford (Conn.) Electric Light Co.

Waldo Weaver has been promoted to the position of combustion engineer for the United Alloy Steel Corp. of Canton, Ohio. He came up from the job of chief of power with the Burger Manufacturing Co., which is now a part of the United company.

Eldon Macleod, treasurer of the Mason Regulator Co., was winner of the golf tournament at the recent meeting of the National Association of Steam Specialty Manufacturers at Swampscott, Mass., after having tied with Byron Atwood, of Atwood & Morrill, Salem, Mass. The finals came out 81-83.

Society Affairs

Coming Conventions

National Association of Practical Refrigerating Engineers—Annual convention at Hotel Lorraine, Philadelphia, Nov. 30-Dec. 3. Secy., Edward H. Fox, 5707 West Lake St., Chicago.

Taylor Society—Annual meeting at New York City, Dec. 1-3. Managing director, H. S. Person, 29 West 39th St., New York City.

American Society of Refrigerating Engineers — Annual meeting at New York City, Dec. 5-7. Secy., William H. Ross, 154 Nassau Street, New York City.

American Society of Mechanical Engineers—Annual meeting at New York City, Dec. 5-9. Topic, "Elimination of Waste." Sec., Calvin W. Rice, 29 West 39th St., New York City.

The Providence Engineering Society will meet Dec. 6 for a talk on "Industrial Management Problems," by L. J. Young.

Virginia Section, A. S. M. E., is to meet Dec. 6 at Murphy's Hotel, Richmond, to discuss "The Engineer in Foreign Trade."

Waterbury Branch, A. S. M. E., will meet Dec. 6 to hear A. C. Moore, of the Charles A. Schieren Co., give a talk on "Belting" that will be illustrated with moving pictures.

Washington, D. C., Section, A. S. M. E., is to hear an address on "Engineering Standardization" on Dec. 9, by A. A. Stevenson, chairman of the American Engineering Standards Committee.

The Society of Naval Architects and Marine Engineers, at its recent general meeting in New York City, elected Walter M. McFarland president. Lewis Nixon, H. I. Cone, C. H. Peabody and J. W. Powell were made vice-presidents, and Daniel H. Cox the secreary. These officers are to serve for a term of three years.

Baltimore Section, A.I.E.E., will devote its December 8 meeting to a study of the Westport Generating Station. The design and construction of the plant will be covered by A. F. Loizeaux, electrical engineer with the Consolidated Gas, Light and Power Co., while operating problems in the station will be taken up by Abbott L. Penniman, superintendent of steam stations with the Consolidated Co. The meeting will begin at 8:15 in the company's service building, and will be followed by a trip through the plant.

Business Items

The O'Brien Machinery Co. has announced its removal to 113 North Third St., Philadelphia, Pa.

The Stewart Heater Co. has been taken over by the King Construction Co., of North Tonawanda, N. Y., and an improved line of Otis and Stewart heaters will be manufactured.

The Bird-Archer Co., which sells "Baco" furnace cement, has announced that a largely increased business is causing its removal on Dec. 1 to 33 Rector St., New York City, where it will occupy an entire fioor.

The Combustion Engineering Corporation, 43 Broad St., New York City, has opened two new branch offices—one at 216 Latta Arcade, Charlotte, N. C., in charge of T. E. Nott, and one at Seattle, Wash., through Fryer-Barker Co., 1133 Henry Building.

The American District Steam Co., North Tonawanda, N. Y., has announced the resignation of B. A. Lewis, as advertising and sales manager of the merchandise division, after 19 years' service. On Jan. 1, 1922, Mr. Lewis will open a sales office in Buffalo, and will specialize on heating equipment, including products of the American District Steam Company.

The Exeter Machine Works, Inc., of West Pittston, Pa., has appointed the W. P. MacKenzie Co. exclusive sales agent for Exeter rotary pumps in the Philadelphia and Baltimore districts. The MacKenzie company specializes in the selling of pumping machinery, and has offices in the Pennsylvania Building in Philadelphia and in the Equitable Building in Baltimore.

The Westinghouse Electric and Manufacturing Co. has announced the following changes in its service department: B. B. Burkett has been appointed district service manager in the Seattle office, succeeding N. P. Wilson, who has been transferred to sales service activities on switchboards and similar apparatus in the Seattle territory; the Salt Lake service department has been made a branch of the Denver office under the direction of A. F. Maccallum, district service manager, Denver. M. R. Davis, formerly district service manager at Salt Lake, will remain at Salt Lake and devote his time to field-service work and to securing repair business for both shops.

Trade Catalogs

Commutator Truing Device — Jordan Bros., Inc., 74 Beekman St., New York City. A folder describing and illustrating a portable grinding device for truing large or small commutators while in service.

An Achievement in Motorships—The McIntosh & Seymour Corporation, Auburn, N. Y. An attractive booklet covering the McIntosh Seymour Marine Diesel Engine. The large number of attractive illustrations of vessels using these Diesels make the booklet extremely attractive.

Valves — Pratt and Cady Co., Inc., Hartford, Conn. Catalog No. 6, an elaborate 6x9-in., 160-page cloth-bound book in which is shown a great variety of brass and iron body valves and asbestos-packed cocks, a number of which have not been described in any previous catalogs of this company. Complete specifications and prices are given.

Air Lift Methods and Apparatus—The Sullivan Machinery Co., Peoples Gas Building, Chicago, Ill. A 40-page pamphlet that describes and explains the air-lift process at considerable length, and gives instructions that would prove useful in ordering such machinery. Two other new bulletins of the company deal with rock drills and with a displacement pump for acids.

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	Nov. 14, 1921	Nov. 21, 1921
Pool 1,	New York	$3.05	$2.90@3.25
Pocahontas,	Columbus	2.55	2.25@2.50
Clearfield,	Boston	1.95	1.60@2.00
Somerset,	Boston	1.90	1.50@2.00
Pittsburgh,	Pittsburgh	2.15	2.10@2.20
Kanawha,	Columbus	2.00	1.75@2.00
Hocking,	Columbus	2.10	1.90@2.10
Pittsburgh No. 8	Cleveland	2.10	2.00@2.05
Franklin, Ill.,	Chicago	3.15	2.50@3.25
Central, Ill.,	Chicago	2.65	2.00@3.00
Ind. 4th Vein,	Chicago	2.80	2.60@2.90
Standard,	St. Louis	2.05	1.90@2.00
West Ky.,	Louisville	2.00	1.75@2.00
Big Seam,	Birmingham	2.15	1.75@2.25
S. E. Ky.,	Louisville	2.10	2.15@2.25

New York — On Nov. 22, Port Arthur light oil 22@25 deg. Baumé, 5½c. per gal.; 30@35 deg., 7c. per gal., f.o.b. Bayonne, N. J.

Chicago—Nov. 19, for 24@28 deg. Baumé, $1.05@$1.10 per bbl.; 32@36 deg. 3¼@3½c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—On Nov. 14 f.o.b. refinery, Pennsylvania, 36@40 deg., 7@8½c. Oklahoma, 24@30 deg., $1.15@$1.35 per bbl.; gas oil, 32@34 deg., 4@4½c. per gal., 36@38 deg., 4½@4¾c., 38@40 deg., 4¾@5c. per gal.

St. Louis—Nov. 19, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, $1 per bbl.; 26@28 deg., $1.10; 28@30 deg., $1.15; 32@34 deg., 2¾c. per gal.

Philadelphia—On Nov. 2., 26@28 deg. Baumé, Oklahoma, $1 per bbl.; 30@34 deg., Oklahoma (group 3), 3c. per gal.; 16@20 deg. Seaboard, 3¾c. per gal.

Cincinnati — Oct. 31, for 26@30 deg. Baumé, 5½c.; Diesel, 30@32 deg. 5¾c. per gal.; 32@34 deg., 6c. per gal.

Cleveland — Oct. 31, for 26@30 deg. Baumé, 4½c. per gal.

New Construction

PROPOSED WORK

Mass., Lawrence — The School Bd., will receive bids until Dec. 15 for a 4 story, 115 x 317 and 92 x 147 ft. addition to high school. About $1,000,000. J. E. Allen, 283 Essex St., Archt.

Conn., Hartford—The Knights of Pythias Bldg. Assn. Committee, J. K. Baskerville, Pres., is having plans prepared for a 4 story, 60 x 150 ft. temple, etc. on High St. About $400,000. Berenson & Moses, 1026 Main St., Archts. Noted Nov. 1.

N. Y., Brooklyn—The Supt. of Pub. Wks., Albany, will receive bids until Dec. 20 for Terminal Contract No. 115, installing electric wiring, power and battery charging equipment for the canal terminal warehouse at Gowanus Bay. About $58,915.

N. Y., Buffalo—Bids will be received by A. W. Kreinhelder, Comr. Pub. Wks., Room 5, Municipal Bldg., until Dec. 5, for furnishing and installing 2 sets of power transformers in the Massachusetts Ave. pumping station and Lakeview Ave. storehouse.

N. Y., Buffalo—The Natl. Lamp Co., Nela Park, East Cleveland, O., is having plans prepared for a 1 story, 40 x 80 ft., boiler house and gas plant, here. About $75,000. G. H. Johnson, Nela Park, East Cleveland, O., Archt.

N. Y., New York—The Estate of A. Finkenberg, 552 Riverside Drive, is having preliminary plans prepared for a 12 story, 75 x 100 ft. office building on 3rd Ave. and 12th St. About $500,000. L. S. Weeks, 101 Park Ave., Archt. and Engr.

N. Y., New York—The Estate of E. H. Van Ingen, c/o Cross & Cross, Archts. and Engrs., 681 5th Ave., is having preliminary plans prepared for a 12 story, 50 x 100 ft. apartment at 956 5th Ave. About $400,000.

N. Y., New York—A. G. Spalding, 126 Nassau St., plans to build a 10 story office and stores building on Nassau and Ann Sts.

N. Y., Syracuse — The Syracuse Hotel Corp., Barney Bldg., is having sketches made for an 11 story hotel on Harrison and Warren Sts. About $2,500,000. G. B. Post & Sons, 101 Park Ave., New York City, Archts. and Engrs. Noted May 23.

N. J., Glassboro—The State Comn. of Educ., State House, Trenton, will receive bids until Dec. 6 for a 2 story, 185 x 260 ft. normal school here. About $500,000. A. H. Moses, Merchantville, and Guilbert & Betelle, 546 Broad St., Newark, Archts. Heating and ventilating system will be separate contract. Noted May 17.

N. J., Jersey City—H. A. Albenesins, 2465 Hudson Blvd., plans to build a 12 story, 110 x 130 ft. apartment on Clifford Ave. and Hudson Blvd. About $800,000. Architect not selected.

N. J., Trenton—C. F. Hildebrecht, West State St., is having plans prepared for an apartment on West State St. About $560,000. W. Harkin, 39 East State St., Archt.

Pa., Altoona—The Altoona School Dist., 6th Ave and 15th Sts., is having plans prepared for a 2 story, 90 x 200 ft., junior high school. About $800,000. J. Millard, Hutchinson Bldg., Altoona, and W. B. ittner, Bd. Educ. Bldg., St. Louis, Mo., Archts.

Pa., McKeesport—The Bd. Educ. plans to build an addition to high school. About $300,000. Architect not selected.

Pa., Philadelphia—The Women's Hospital of Philadelphia., E. K. Lehman, is having plans prepared for a 6 story, 50 x 100 ft. hospital on 22nd and North College Ave. About $250,000. C. A. Ziegler, 1218 Chestnut St., Archt.

Del., Wilmington—C. Warner Co., A. D. Warner, Jr., Purch. Agt., is in the market for two dredging pumps and a centrifugal water pump.

D. C., Bellevue—The Bureau of Yards and Docks, Navy Dept., Wash., plans to install power plant equipment here. Spec. 4497.

D. C., Washington—F. H. Smith Co., 815 15th St., N.W., representing owner, is having plans prepared for a hotel at 15th and K Sts., N.W. About $500,000. J. H. de Sibour, Hibbs Bldg., archt.

W. Va., Glen Jean — The Appalachian Power Co., Bluefield, is having plans prepared for an addition to power plant, increasing capacity from 20,000 to 40,000 kw. New equipment including generating machinery, boilers, etc., will be required. Viele, Blackwell & Buck, 49 Wall St., New York City, engrs.

W. Va., Pikeville—The Kentucky & West Virginia Power Co., Church St., New York City is having plans prepared for a power house here. R. F. Weller, Hibbs Bldg., Washington, D. C., engr.

Ga., Savannah—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will receive bids until Dec. 14 for construction of Radio station quarters. Spec. 4517.

Fla., Williston—The city will have bond election called Dec. 28 for a water and electric light plant. About $35,000. F. F. Capps, Mayor.

O., Cleveland—The Chestnut-12th St. Co., c/o W. S. Ferguson & Co., engrs., 1900 Euclid Ave., is having plans prepared for a 12 story commercial and office building on East 12th St. and Chestnut Ave. About $1,000,000.

O., Cleveland—The city will receive bids until Dec. 2 furnishing 75 gal. per minute pressure booster pump. G. B. Gascoygne, City Hall, engr.

O., Columbus—The Bd. of Trustees, Ohio State University, C. E. Steel, Clk., received bids for a 1 story, 100 x 300 ft. addition to power house from E. Elford, 307 East Gay St., $162,900; E. H. Gotham Co., 60 East Broad St., $167,693; and R. H. Evans Co., Ferris Bldg., $178,693. Noted Nov. 8.

Mich., Detroit — The Cooper Constr. & Realty Co., 322 West Fort St., is having plans prepared for a 10 story, 60 x 180 ft., apartment hotel, including vacuum steam heating and refrigeration plants, on Woodward Ave. M. H. Finkel, 333 Majestic Bldg., archt.

Mich., Detroit — A. H. Gould & Son, archts. and engrs., 610 Empire Bldg., will receive bids until Jan. 1 for a 13 story, 93 x 160 ft. office building, including a steam heating system, on Clifford and Columbia Sts., for United Brotherhood of M. of W. E. & R. S. L., 61 Putnam Ave. About $1,250,000.

Mich., Grand Rapids—The Furniture City Realty Co., 515 Lyons Ave., is having plans prepared for an 8 story, 152 x 154 ft., hotel including a steam heating system on Monroe Ave. About $1,000,000. B. K. Gibson & Co., 608 South Dearborn St., Chicago, archts.

Mich., Saginaw—Cowles & Mutscheller, Chase Block, will receive bids until Dec. 7 for a 3 story, 176 x 291 ft. junior high school on Weadock St., S., for the Board of Education. About $850,000. Three, 175 hp. boilers will be installed.

Ill., Joliet—The Flint Sanitary Mills Co., c/o G. & T. Flint, is having plans prepared for a dairy building. About $150,000. H. A. Hahn, c/o Davis-Watkins Dairymans Mfg. Co., Davis and 23rd Sts., North Chicago, archts and engrs.

Ill., Rogers Park—V. G. Seaver, c/o Newhouse & Bernham, archts., 4630 Prairie Ave., Chicago, having sketches made for a 4 story, 150 x 175 ft. theatre and apartment building, including a steam heating system on Howard St. and Malvern Ave. About $2,000,000.

Ill., Zeigler—The Zeigler Ice & Bottling Co., is having plans prepared for a 2 story, 93 x 105 ft., ice plant. About $50,000. Kennerly & Stiegemeyer, Title Guaranty Bldg., St. Louis, Mo., archts. Noted Nov. 15.

Wis., Fond du Lac—The Wisconsin Hotel Co., D. Sargent, c/o Palmer House, 29 South Main St., Genl. Mgr., is having plans prepared for an 8 story, 40 x 180 and 40 x 80 ft. hotel on South Main St. About $400,000. N. S. Spencer & Son, 37 West Van Buren St., Chicago, Ill., archts.

Wis., Green Bay—The Bd. Educ., A. W. Burton, secy., is having plans prepared for a 4 story, 160 x 230 ft. senior high school including a steam heating system. About $500,000. Foeller, Schoeber Co., 123 North Washington St., archts. Noted Oct. 4.

Wis., Janesville—The New Soty Mfg. Co., 302 North Main St., manufacturers of steel dies and presses, is in the market for equipment and machinery for new power plant.

Wis., Madison—The Bd. of Regents, University of Wisconsin, M. E. McCaffery, secy., is having plans prepared for a 6 story, 150 x 250 ft. hospital on Warren St. About $1,200,000. A. Peabody, Capitol Bldg., archt.

Wis., Making (Antigo P. O.)—C. & R. T. Wunderlech Co., Antigo, plans to rebuild electric light plant and dam. About $50,000. Engineer not selected.

Wis., Milwaukee—The B. P. O. E. No. 46, 448 Jefferson St., is receiving competitive sketches for a 5 story, 132 x 160 ft. club house on Mason St. Cost between $500,000 and $600,000. Architect not selected.

Wis., Milwaukee—Saxe Bros., 106 5th St. and O. Brachman, 425 East Water St., are having preliminary plans prepared for a 7 or 8 story, 150 x 200 ft. theatre and office bldg. on Grand Ave. and 6th St. About $2,000,000. M. Tullgren & Sons, 425 East Water St., archts. Noted May 10.

Wis., Milwaukee—The School Bd., F. Horbach, secy., 10th and Prairie Sts., will receive bids until Dec. 1 for a one story, 20 x 45 ft. boiler house and heating plant at the 2nd Ave. school. About $50,000. Van Ryn & De Gelleke, 114 Grand Ave., archts. Two 150 hp. boilers will be installed.

Wis., Soldiers Grove—The Peterson Estate Co. will receive new bids soon on machinery and equipment for new power house and plant. Noted Oct. 25.

Wis., Stoughton—The Stougton Wagon Co., F. J. Vea, mgr., plans to build a 1 and 2 story, 75 x 210 ft. factory bldg., on Main St. About $300,000. Architect not selected.

Ia., Modale—The city voted $14,300 bond issue for the construction of water works system including well, pump and cast iron mains. C. L. Huff, Logan, engr.

Minn., Minneapolis—The Bd. Educ., G. F. Womrath, supt., will receive bids until Dec. 9 for a 3 story, 218 x 230 ft. junior high school including a steam heating system on Clinton Ave. and 38th St. About $600,000. E. H. Enger. 305 City Hall, archt.

Kan., Independence — N. S. Spencer, archt., 37 West Van Buren St., Chicago, Ill., will receive bids until about Dec. 15 for a 3 story, 180 x 235 ft. junior high school including a steam heating system, for the Bd. Educ., C. S. Risdon, supt. About $400,000.

Kan., Leavenworth—The Bd. Educ., c/o M. E. Moore, supt., plans to build a 2 story, junior high school. About $450,000. Architect not selected.

Kan., Topeka—J. W. Renker, 822 Kansas Ave., is having plans prepared for an 8 story, 100 x 150 ft. hotel, including a steam heating system. About $700,000. W. Wahlschlager, 65 East Huron St., Chicago, Ill., archt.

Neb., Lincoln—The city will receive bids until Dec. 10 for the installation of a 1,000 hp. economizer, vertical cast iron tube type, engine driven, steel plate type, induced fan, chain grate stokers and superheaters for two 500-hp. boilers; one open feed water heater for 4,500 lb. per hour, one hot process water softener, 2,000 gal. per hour, one centrifugal motor driven boiler feed pump, 150 gal. per minute, and two soot blowers. About $42,000. G. W. Bates, Engr.

S. D., Huron—The Bd. of Supervisors, Beadle County, will receive bids until Dec. 14 for a 3 story, 98 x 114 ft. court house, including a steam heating system. About $300,000. W. E. Hulse & Co., 380 Grain Exchange Bldg., Sioux City, Ia., archts.

Mo., Aurora—The Helvetia Milk Co., c/o J. A. Potter, plans to build a 2 story milk condensery. About $200,000. Architect not selected.

Mo., Desalia—The Weber Ice Cream Co. has had plans prepared for a 1 story ice plant at 518 South Ohio St. About $5,000. Private plans. Ice making machinery will be installed.

Mo., Kansas City—The Bellerive Investment Co., 111 North 7th St., c/o F. J. Cornwall, Sr., is having plans prepared for a 15 story, 110 x 203 ft. apartment hotel bldg. on Armour and Warwick Blvds. About $1,000,000. P. J. Bradshaw, International Life Bldg., St. Louis, archt.

Tex., Kerrville—S. B. Cowell, chn., State Bd. of Control will receive bids until Dec. 5 for a group of buildings including boiler house, and 155 ft. smoke stack, installation of a steam heating plant, three 250 hp. boilers and a 200 kw. generator plant. About $650,000. Phelps & Dewees, Gunter Bldg., San Antonio, engrs. and archts.

Ore., Grants Pass—The city plans irrigation system, covering 800 acres, pumping plant and distribution system. About $25,000. G. Stubblefield, Grants Pass, engr.

Ore., Milton—K. G. Harlan plans to build a 3375 hp. hydro-electric plant, including dam, power house, pipe line and transmission lines. About $350,000. A. E. Perry, Pendleton, engr.

Ore., Portland—Meier & Frank, 5th and Morrison Sts., is having plans prepared for a 10 story wholesale and mailorder building at 13th, 14th, Everett and Flanders Sts. About $1,000,000. Sutton & Whitney, Lewis Bldg., archts.

Cal., Pasadena—The city is having plans prepared for a high school consisting of 4 buildings on Penn and Raymond Sts. About $500,000. Allison & Allison, 1405 Heberman Bldg., Los Angeles, archts.

Ont., Belmont—Dorchester Twp., c/o J. Procunieu, plans to construct power lines to Nilestown, Belmont and Harrietsville under the direction of The Ontario Hydro Comn., University Ave., Toronto, Sir A. Beck, 169 Albert St., London, chn. About $90,000. J. N. Wilson, 90 University Ave., Toronto, engr.

Ont., Petrolea—The town is having plans prepared for the installation of a waterworks reservoir and electrical driven centrifugal pumps. About $42,000. James, Proctor & Redfern, 36 Toronto St., Toronto, engrs.

CONTRACTS AWARDED

Mass., Haverhill—The C. M. Hilley Bros. Co., 30 Pleasant St., will build a 7 story shoe factory on Water, Chestnut and School Sts. About $500,000. Work will be done by day labor.

N. Y., New York—The Family Laundry Corp., 1471 Wilkins Ave., has awarded the contract for a 2 story laundry on 5th Ave. and 141st St. to J. Zimmerman, 18 East 40th St. About $400,000.

N. Y., New York—M. Kaufman, c/o C. Kreymborg, archt., 2534 Marion Ave., will build a 5 story, 90 x 100 ft. apartment on 180th St. and Audubon Ave. About $250,000. Owner will build by day labor.

N. Y. New York — The Nine-Hundred-Twenty 5th Ave. Corp., c/o J. E. Carpenter, Archt., 681 5th Ave., will build a 13 story apartment on 5th Ave. and 73rd St. About $700,000. Work will be done by separate contracts.

N. Y., New York—F. Starkman, c/o C. Kreymborg, archt., 2534 Marion Ave., will build a 5 story, 200 x 250 ft. apartment on Stebbins Ave. About $250,000. Owner will build by day labor.

N. Y., Mt. Vernon—The Willow Brook Dairy Co., 5 South Fulton Ave., has awarded the contract for a 1 and 2 story dairy bldg. and garage to Barney Ahlers Co., 110 West 40th St., New York City. About $300,000. Noted April 5.

Pa., Harrisburg—The city has awarded the contract for the installation of two 15,000,000 gal. pumps, boilers and boiler house, etc. to J. H. Wickersham, Brennan Bldg., Lancaster, $243,622.12. Noted Nov 1.

Pa., Philadelphia—The Franklinville Ice Co., 5166 Jefferson St., has awarded the contract for an addition to ice plant on Jefferson St. to the York Mfg. Co., 2222 Arch St. $38,000.

Pa., Philadelphia—The Sweeten Automobile Co., Parkway Bldg., has awarded the contract for an office bldg. on Broad and Cherry Sts. to Irwin & Leighton, 126 North 12th St. About $800,000.

Md., Cumberland—The city has awarded the contract for a 1 story, 20 x 30 ft. pumping station, to Vang Constr. Co., 21 3rd Natl. Bank Bldg., $46,000.

Ga., Atlanta—The Atlanta Ice & Coal Co., Washington St. Viaduct, has awarded the contract for a 2 story ice plant on Murphy and Benjamin Sts. to the Foundation Co., 3rd Natl. Bank Bldg. About $150,000. Machinery and equipment for ice plant will be installed.

Mich., Detroit—The Chippewa Apartment Co., c/o J. W. Wilson, archt., 750 David Whitney Bldg., has awarded the contract for masonry for a 7 story apartment on Parker and Agnes Aves., to O. Misch Co., Detroit Savings Bank Bldg., $750,000. Steam heating plant will be installed.

Wis., Milwaukee—The Castle Ice Gardens, 197 Ogden Ave., has awarded the contract for a 1 story, 150 x 220 ft. ice rink on 35th and Wells Sts. to Raulf Co., 428 Grand Ave. About $200,000.

Wis., Milwaukee—F. C. Gross Bros. Co., 133 Muskego Ave., will build a 1 and 2 story, 56 x 145 ft. cold storage warehouse on Muskego Ave. About $40,000. Work will be done by day labor.

Mo., St. Louis—The Christian Brother's College, c/o B. Baldwin, has awarded the contract for a 3 story college on Clayton Rd. and University Lane to the Kellerman Constr. Co., Victoria Bldg. About $500,000. Noted Jan. 18.

Idaho, Post Falls—The city has awarded the contract for new water work system including multiple stage centrifugal pump to the Standard Asphalt Paving Co., 517 North Lincoln St., Spokane, Wash., $41,231.

Ont., Georgetown—The city has awarded the contract for the installation of a waterworks pumping plant to Goldie & McCullough, Galt, $9,384. Noted Sept. 27.

Ont., Toronto — Chapmans, Ltd., Kent Bldg., has awarded the contract for an artificial ice plant to W. M. Sutherland Co., Ltd., Lumsden Bldg., $70,000.

Man., Lac-du-Bonnet — The Manitoba Power Co., Ltd., Electric Railway Chambers, Winnipeg, A. W. McLimont, mgr., has awarded the contract for 168,000 hp. hydro-electric development at Great Falls, near here, to the Northern Construction, Union Bank Bldg., Winnipeg, and Fraser Brace, Ltd., 83 Craig St., W., Montreal. Total cost, $10,000,000. Contract let for about 50% of project.